NAVSHIPS [redacted] 91692

INSTRUCTION BOOK

for

TEST SET TS-147C/UP

ESPEY MANUFACTURING COMPANY, INC.
NEW YORK 21, N. Y.

NAVY DEPARTMENT BUREAU OF SHIPS

Contract: NObsr 49265 *Approved by BuShips: 16 June 1952*

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NOTE

Change NAVSHIPS 91962 on all pages of this Instruction Book to read NAVSHIPS 91692.

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LIST OF EFFECTIVE PAGES

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ADDRESS NAVY DEPARTMENT,
BUREAU OF SHIPS

NAVY DEPARTMENT
BUREAU OF SHIPS
WASHINGTON 25, D. C.

REFER TO FILE NO.
Code 993-100
12 June 1952

From: Chief, Bureau of Ships

To: All Activities Concerned with the Installation, Operation and Maintenance of the Subject Equipment

Subj: Instruction Book for Test Set TS-147C/UP NAVSHIPS 91692

1. This is the instruction book for the subject equipment and is in effect upon receipt.

2. When superseded by a later edition, this publication shall be destroyed.

3. Extracts from this publication may be made to facilitate the preparation of other Department of Defense Publications.

4. All Navy requests for NAVSHIPS Electronics publications should be directed to the nearest District Publications and Printing Office. When changes or revised books are distributed, notice will be included in the Bureau of Ships Journal and in the Index of Bureau of Ships General and Electronics Publications, NAVSHIPS 250-020.

H. N. WALLIN
Chief of Bureau

RECORD OF CORRECTIONS MADE

CHANGE NO.	DATE	SIGNATURE OF OFFICER MAKING CORRECTION

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GUARANTEE

The equipment, including all parts and spare parts, except vacuum tubes, batteries, rubber and material normally consumed in operation, is guaranteed for a period of one year from the date of delivery of the equipment to and acceptance by the Government with the understanding that all such items found to be defective as to material, workmanship or manufacture will be repaired or replaced, f. o. b. any point within the continental limits of the United States designated by the Government, without delay and at no expense to the Government; provided that such guarantee will not obligate the Contractor to make repair or replacement of any such defective items unless the defect appears within the aforementioned period and the Contractor is notified thereof in writing within a reasonable time and the defect is not the result of normal expected shelf life deterioration.

To the extent the equipment, including all parts and spare parts, as defined above, is of the Contractor's design or is of a design selected by the Contractor, it is also guaranteed, subject to the foregoing conditions, against defects in design with the understanding that if ten percent (10%) or more of any such said item, but not less than two of any such item, of the total quantity comprising such item furnished under the contract, are found to be defective as to design, such item will be conclusively presumed to be of defective design and subject to one hundred percent (100%) correction or replacement by a suitably redesigned item.

All such defective items will be subject to ultimate return to the Contractor. In view of the fact that normal activities of the Naval Service may result in the use of equipment in such remote portions of the world or under such conditions as to preclude the return of the defective items for repair or replacement without jeopardizing the integrity of Naval communications, the exigencies of the Service, therefore, may necessitate expeditious repair of such items in order to prevent extended interruption of communications. In such cases the return of the defective items for examination by the Contractor prior to repair or replacement will not be mandatory. The report of a responsible authority, including details of the conditions surrounding the failure, will be acceptable as a basis for affecting expeditious adjustment under the provisions of this contractual guarantee.

The above one year period will not include any portion of time the equipment fails to perform satisfactorily due to any defects, and any items repaired or replaced by the Contractor will be guaranteed anew under this provision.

INSTALLATION RECORD

Contract: NObsr-49265 Date of Contract, 29 June 1950

Serial Number of equipment.....

Date of acceptance by the Navy.....

Date of delivery to contract destination.....

Date of completion of installation.....

Date placed in service.....

Blank spaces on this page shall be filled in at time of installation. Operating personnel shall also mark the "date placed in service" on the date of acceptance plate located below the model nameplate on the equipment, using suitable methods and care to avoid damaging the equipment.

REPORT OF FAILURE

Report of failure of any part of this equipment, during its entire service life, shall be made to the Bureau of Ships in accordance with current regulations using form NAVSHIPS 383 (revised). The report shall cover all details of the failure and give the date of installation of the equipment. For procedure in reporting failures, see Chapter 67 of the *Bureau of Ships Manual* or superseding instructions.

ORDERING PARTS

All requests or requisitions for replacement material should include the following data:

1. Federal stock number or, when ordering from a Marine Corps or Signal Corps supply depot, the Signal Corps stock number.
2. Name and short description of part.

If the appropriate stock number is not available the following shall be specified:

1. Equipment model or type designation, circuit symbol, and item number.
2. Name of part and complete description.
3. Manufacturer's designation.
4. Contractor's drawing and part number.
5. JAN or Navy type number.

DESTRUCTION OF ABANDONED MATERIAL IN THE COMBAT ZONE

In case it should become necessary to prevent the capture of this equipment, and when ordered to do so, DESTROY IT SO THAT NO PART OF IT CAN BE SALVAGED, RECOGNIZED, OR USED BY THE ENEMY. BURN ALL PAPERS AND BOOKS.

Means:

1. Explosives, when provided.
2. Hammers, axes, sledges, machetes, or whatever heavy object is readily available.
3. Burning by means of incendiaries such as gasoline, oil, paper or wood.
4. Grenades and shots from available firearms.
5. Burying all debris, where possible and when time permits.
6. Throwing overboard or disposing of in streams or other bodies of water.

Procedure:

1. Obliterate all identifying marks. Destroy nameplates and circuit labels.
2. Demolish all panels, castings, switch and instrument boards.
3. Destroy all controls, switches, relays, connections and meters.
4. Rip out all wiring and cut interconnections of electrical equipment. Smash gas, oil, and water cooling systems in gas engine generators, etc.
5. Smash every electrical or mechanical part, whether rotating, moving or fixed.
6. Break up all operating instruments such as keys, phones, microphones, etc.
7. Destroy all classes of carrying cases, straps, containers, etc.
8. Bury or scatter all debris.

DESTROY EVERYTHING!

SAFETY NOTICE

The attention of officers and operating personnel is directed to Chapter 67 of the *Bureau of Ships Manual* or superseding instructions on the subject of radio-safety precautions to be observed.

This equipment employs voltages which are dangerous and may be fatal if contacted by operating personnel. Extreme caution should be exercised when working with the equipment.

While every practicable safety precaution has been incorporated in this equipment, the following rules must be strictly observed:

KEEP AWAY FROM LIVE CIRCUITS:

Operating personnel must at all times observe all safety regulations. Do not change tubes or make adjustments inside equipment with high voltage supply on. Under certain conditions dangerous potentials may exist in circuits with power controls in the off position due to charges retained by capacitors. To avoid casualties always remove power and discharge and ground circuits prior to touching them.

DON'T SERVICE OR ADJUST ALONE:

Under no circumstances should any person reach within or enter the enclosure for the purpose of servicing or adjusting the equipment without the immediate presence or assistance of another person capable of rendering aid.

DON'T TAMPER WITH INTERLOCKS:

Do not depend upon door switches or interlocks for protection but always shut down motor generators or other power equipment. Under no circumstances should any access gate, door, or safety interlock switch be removed, short-circuited, or tampered with in any way, by other than authorized maintenance personnel, nor should reliance be placed upon the interlock switches for removing voltages from the equipment.

RESUSCITATION

AN APPROVED POSTER ILLUSTRATING THE RULES FOR RESUSCITATION BY THE PRONE PRESSURE METHOD SHALL BE PROMINENTLY DISPLAYED IN EACH RADIO, RADAR, OR SONAR ENCLOSURE. POSTERS MAY BE OBTAINED UPON REQUEST TO THE BUREAU OF MEDICINE AND SURGERY.

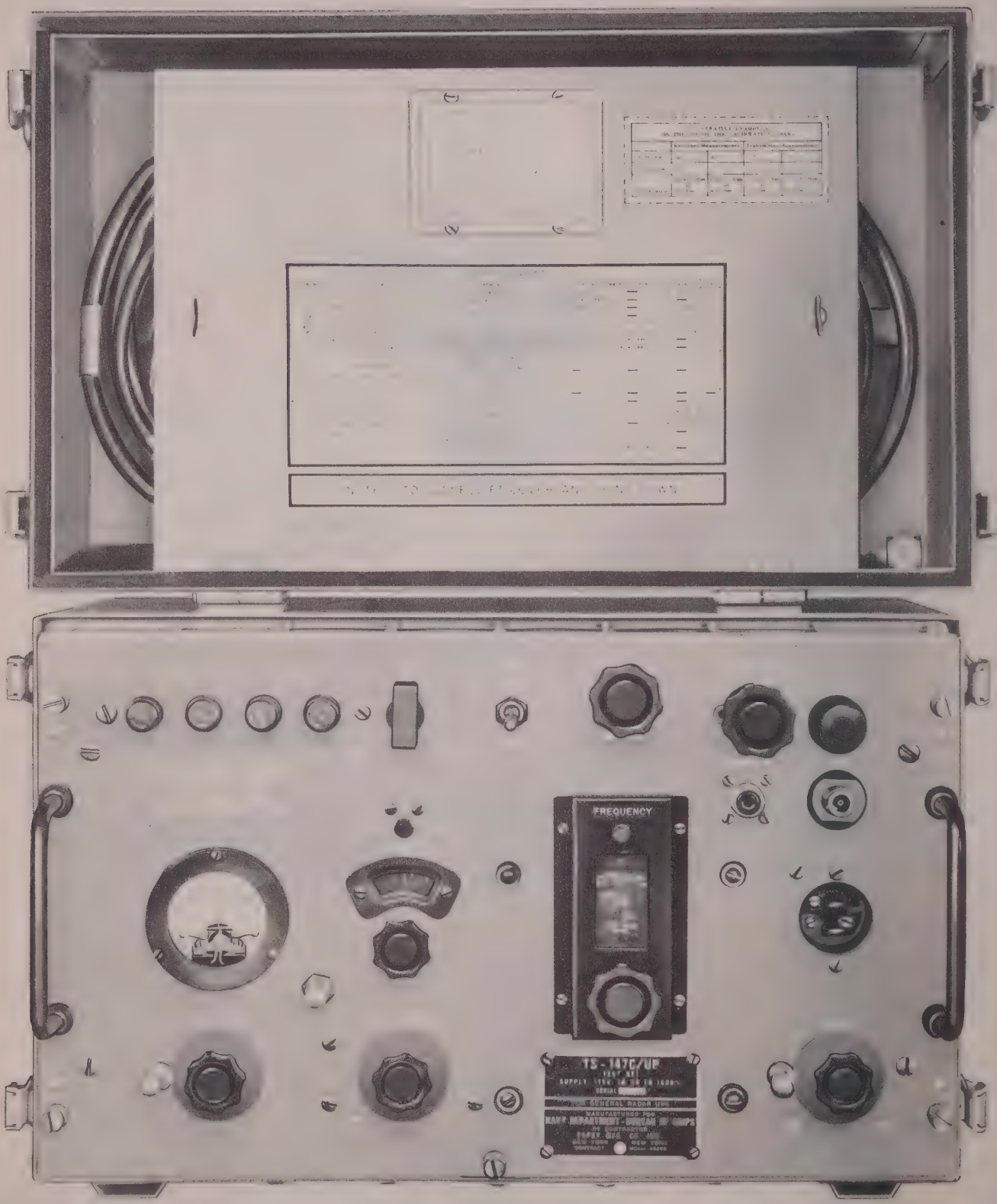


Figure 1—1. Test Set TS-147C/UP, Complete Equipment.

SECTION 1

GENERAL DESCRIPTION

1. SCOPE OF INSTRUCTION BOOK.

This Instruction Book contains descriptive material and instructions for the installation, operation and maintenance of Test Set TS-147C/UP. This manual has been prepared for the use of personnel concerned with the operation and repair of Test Set TS-147C/UP. A thorough study of its contents will facilitate the work of the personnel concerned.

2. PURPOSE AND BASIC PRINCIPLES.

(See figs. 1-1 and 1-2.)

a. Test Set TS-147C/UP is a portable microwave signal generator designed for testing and adjusting beacon equipment and radar systems which operate within the frequency band of 8500 mc to 9600 mc.

b. The test set supplies microwave test signals (either FM or CW) of known power level and frequency. These signals together with the aid of an oscilloscope (A-type scan) for observing the radar video output can be used in visual alignment methods in testing and adjusting radar systems. The sweep of the test signal frequency modulation and the horizontal sweep of the oscilloscope are triggered in synchronism with the radar system firing cycle. Because this timing makes the horizontal A-scope sweep proportional to the frequency of the FM test signals, the resulting pattern seen on the A-scope represents the frequency response curve of the receiver section of the radar system. The oscilloscope pattern shows the effect of system adjustments.

Figure 1—2. Test Set TS-147C/UP Stowed for Carrying.

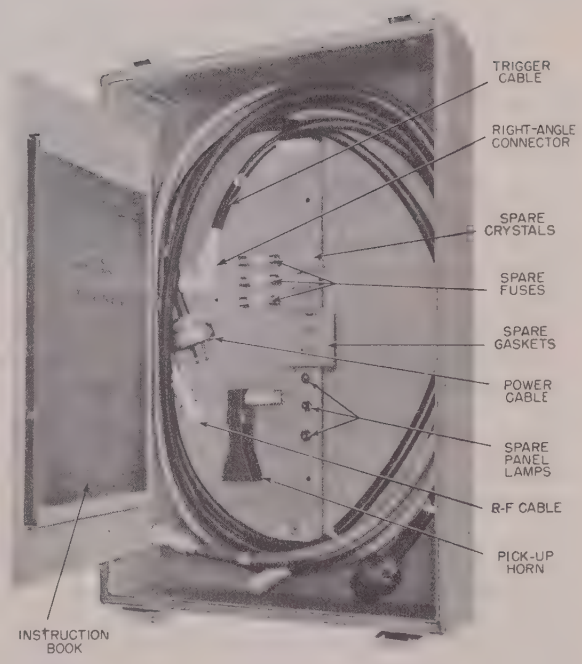


Figure 1—3. Test Set Accessories.

c. The test set contains a direct reading frequency meter and a power level meter which measures power referenced to one milliwatt. These meters can be used for measuring either input or output power levels and frequencies of the same without any auxiliary equipment.

3. DESCRIPTION OF TEST SET TS-147C/UP COMPONENTS.

(See table 1-1 and figure 1-3.)

a. PICKUP ANTENNA AT-68/UP.

The pickup horn is a small directive antenna assembly which can be used for both receiving external r-f energy to be measured by the test set and for transmitting the r-f

test signal generated in the test set. The horn consists of a tapered section of waveguide which is terminated by a probe coupling to a coaxial fitting. The horn is connected to the r-f receptacle on the test panel by means of the r-f cable assembly CG-92A/U (8).

b. RF CORD ASSEMBLY CG-92A/U (8).

This cable is used for making the r-f connection to the radar system under test; either a directional coupler or pickup horn is used to complete the r-f connection. The cable assembly consists of 8 feet of RG-9A/U cable fitted with two UG-21B/U connectors. Connection is made to the UG-23/U receptacle marked R-F on the front panel.

c. TRIGGER CORD ASSEMBLY CG-638/U (6).

This cable is used for connecting a trigger voltage to the test set when it is not possible to trigger the set by means of r-f pulses. The cable assembly consists of 6 feet of RG-11/U cable fitted with two Navy type 49195 connectors. One of the 49195 connectors is fitted with a Navy 49192 right angle connector for convenience in shipping the right angle connector (fig. 1-3). The trigger cable connects to the receptacle marked TRIGGER on the front panel.

d. POWER CORD ASSEMBLY CX-337/U (6).

Connection of the test set to a 115 volt AC power source is made by means of this cable. The assembly consists of 6 feet of rubber-covered two conductor cord fitted with a female and male plug. The female plug connects to the receptacle marked 115V AC on the control panel. The male plug will fit a standard two-prong wall type receptacle.

e. OPERATION SPARES. (Figure 1-3.)

The following operating spares are supplied to replace corresponding parts in the test set:

(1) THERMISTOR MOUNT MX-435/UP. – One calibrated thermistor mount complete with bead and disc thermistors. This spare is bolted inside the test set chassis.

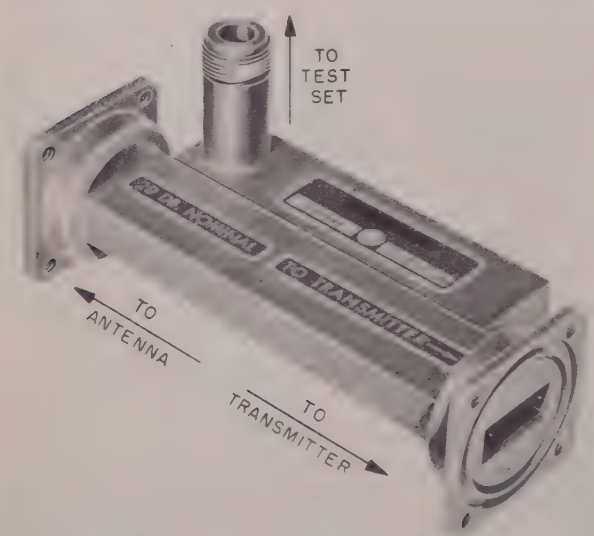


Figure 1—4. Directional Coupler.

(2) FUSES.—Five 2 ampere type 3AG cartridge fuses, two of which are mounted in the holders marked SPARES on the control panel.

(3) GASKETS.—Nine gaskets used in waveguide plans joints. (See figures 1-3 and 2-4.)

(4) LAMPS.—Three 3.0 volt panel lamps.

(5) CRYSTALS. – Two Navy type 1N23B silicon rectifier crystals to replace the crystal in the r-f output and detector section.

f. CALIBRATION CHART (See figure 1-6).

The calibration chart mounted inside the cover of the case indicates the correction to be applied to the DBM dial reading to indicate the attenuation of the calibrated attenuator. The correction figures carry their own sign and are to be added or subtracted from the DBM dial reading regardless of whether receiver (−dbm) or transmitter (+dbm) measurements are being made. To illustrate the use of the calibration chart the following examples are given. For receiver measurements, if the DBM dial reading is (−)60 dbm enter the calibration chart at −60 along the horizontal axis and read the correction figure say −3 as indicated by the applicable black line representing the test frequency. The attenuation is then −(60−3)dbm or −57 dbm. If the correction figure is +3 the attenuation becomes −(60+3) dbm or −63dbm. Similarly for transmitter measurements if the DBM dial reads (+)25 dbm enter the calibration chart at 25 along the horizontal axis and read the correction figure, say −3, as indicated by the red line representing the test frequency. The corrected attenuation is then +(25−3) dbm or +22 dbm. If the corrected figure is 3 the corrected attenuation is then +(25+3) dbm or +28 dbm.

4. REFERENCE DATA.

a. NOMENCLATURE.—Test Set TS-147C/UP.

b. CONTRACT DATA.—Contract NObsr-49265.

c. COGNIZANT NAVAL INSPECTOR. – Inspector of Naval Material, New York City, N. Y.

d. EQUIPMENT CUBICAL CONTENTS.

(1) CRATED.—3.73 cubic feet.

(2) UNCRATED.—1.75 cubic feet.

5. ELECTRICAL CHARACTERISTICS.

a. FREQUENCY METER.

(1) RANGE.—8500 mc to 9600 mc.

(2) ABSOLUTE ACCURACY.– ± 2½ mc at 25°C and 60% relative humidity.

(3) RELATIVE ACCURACY.– ± 1.0 mc for frequency increments of less than 60 mc.

(4) CALIBRATION POINTS.—9300 ± 1.0 mc at 25°C and 60% relative humidity.

b. POWER METER.

(1) INPUT SIGNALS. (Average Power Levels.)

(a) RANGE.—plus 7 to plus 30 dbm at r-f receptacle.

(b) ACCURACY.– ± 2.0 db.

(2) OUTPUT TEST SIGNALS. (Peak Mode Power.)

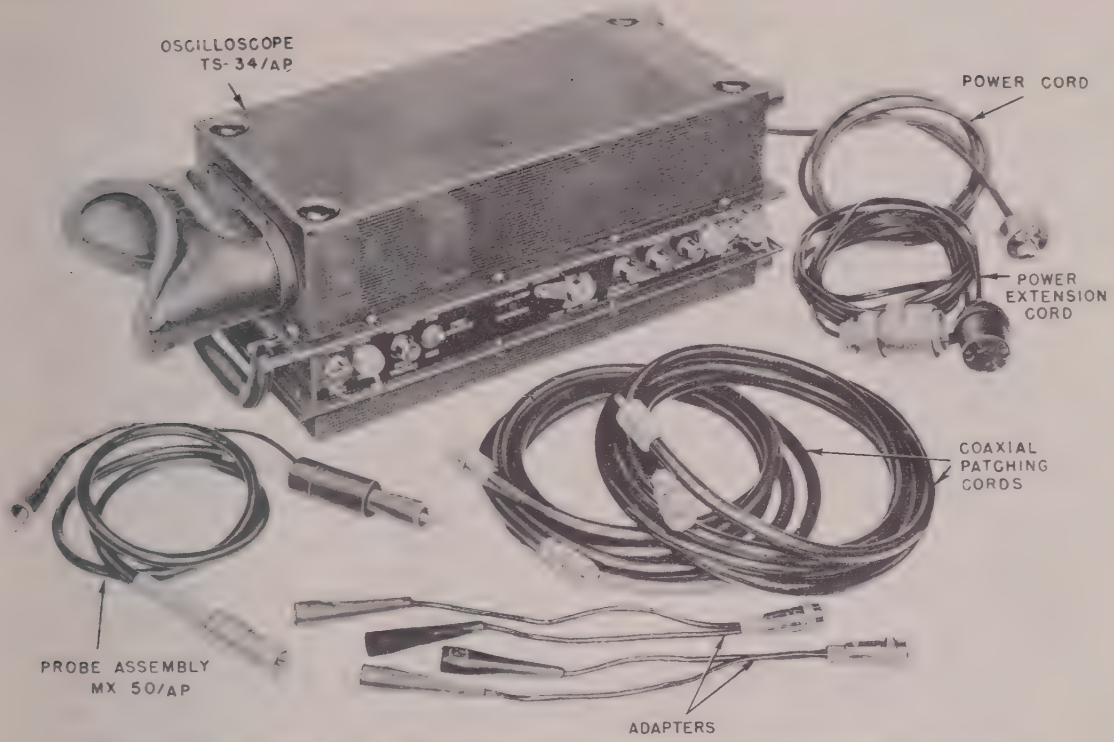


Figure 1—5. Oscilloscope TS-34/AP, Equipment Required but Not Supplied.

a. RANGE.—42 to −83 dbm at r-f receptacle.
b. ACCURACY.— ± 2.0 db.

Note

Accuracy of power measurements depend upon calibration of directional coupler and r-f cable losses. The stated tolerances assume use of the calibration chart supplied with the test set. (See figure 1-6.)

c. SIGNAL GENERATOR.

(1) Tuning range; 8500 mc to 9600 mc, provided a suitable oscillator tube is available.

(2) Power output; as specified in 5b (2) (a).

(3) Frequency modulation.

(a) Sweep rate; 0 to 6 mc/US for oscillator tubes having at least 3 mc/volt tuning range.

(b) Center frequency range; as specified in 5.C. (1).

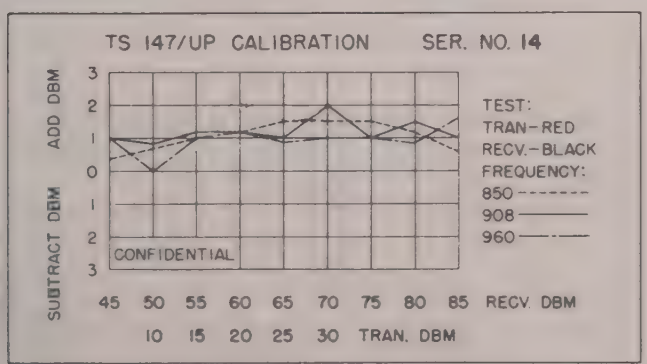


Figure 1—6. Sample Calibration Chart.

TABLE 1-1. EQUIPMENT SUPPLIED

QUANTITY PER EQUIPMENT	NAME OF UNIT	NOMENCLATURE	HEIGHT (Inches)	WIDTH (Inches)	DEPTH (Inches)	VOLUME (Cu. Ft.)	WEIGHT LBS. WITH CONTENTS
1	TEST SET (complete)	TS-147C/UP	$12\frac{13}{16}$	$11\frac{7}{8}$	$19\frac{1}{2}$	1.75	35
1	*Horn pickup	AT-68/UP	$4\frac{1}{2}$	$2\frac{1}{4}$	$6\frac{3}{4}$	0.04	0.14
1	*RF Cable Assembly	CG-92A/U (8)			8 ft.		
1	*Trigger Cable Assembly	CG-638/U (6)			6 ft.		
1	*Cable Assembly Power	CX-337/U (6)			6 ft.		
1	Right Angle Adapter						
1 set	±Operating spares consisting of:						
3	*Panel lamp						
2	*Crystal silicon diode	1N23B					
1	+Thermistor Mount	MX-435/UP					
9	*Gasket						
5	*Fuse						

*Item packed in cover of test set carrying case. +Mounted on chassis of test set. ±Described in paragraph 4.

TABLE 1-2. EQUIPMENT REQUIRED BUT NOT SUPPLIED

QUANTITY PER EQUIPMENT	NAME OF UNIT	NOMENCLATURE	REQUIRED USE	REQUIRED CHARACTERISTICS
1	*Oscilloscope	TS-34/AP series or equivalent	Receiver tests	Start-stop sawtooth sweep triggered at radar recurrence frequency to produce A type scan. (Portable type).
1	*Oscilloscope	TS-239/UP series or equivalent	Receiver tests	Same as above. (Bench type).
1	Directional Coupler	CG-176/AP	Quantitative measurements	

*Either oscilloscope may be used.

TABLE 1-3. SHIPPING DATA

SHIPPING BOX NO.	CONTENTS		OVERALL DIMENSIONS			VOLUME Cu. Ft.	WEIGHT
	NAME	DESIGNATION	HEIGHT (Inches)	WIDTH (Inches)	DEPTH (Inches)		
1	TEST SET	TS-147C/UP	17	$15\frac{1}{2}$	$22\frac{1}{2}$	3.45	55 lbs.

TABLE 1-4. ELECTRON TUBE COMPLEMENT

JAN TUBE TYPE	SYMBOLS INVOLVED	QUANTITY PER EQUIPMENT	DESCRIPTION
5R4GY	V-101	1	Full wave rectifier
6Y6-G	V-102	1	Beam power amplifier
6SH7	V-103	1	HF amplifier pentode
2K25	V-104	1	Klystron, integral cavity
0C3/VR-105	V-105, V-106	2	Voltage regulator
6SL7-GT	V-107, V-108	2	Twin triode

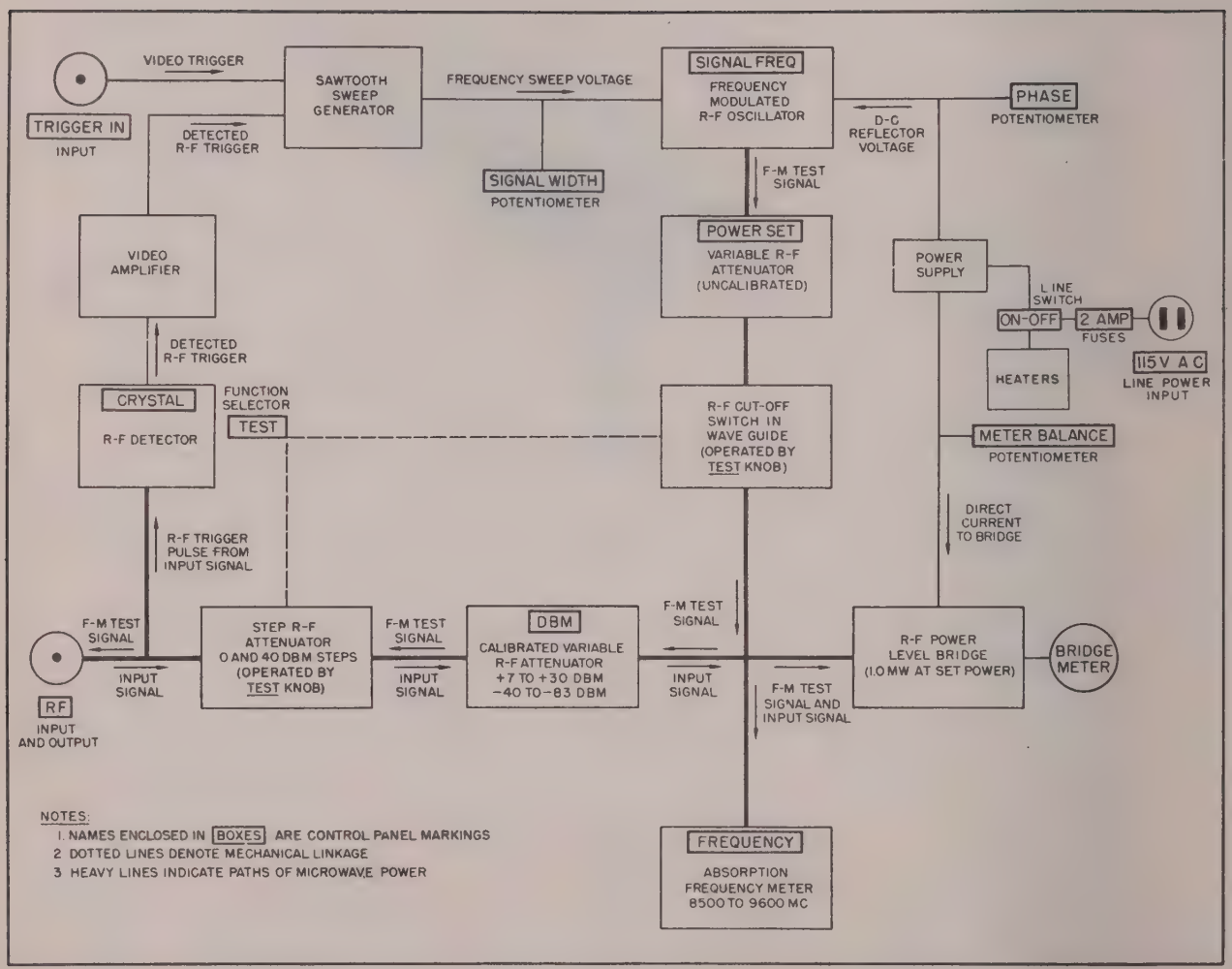


Figure 2—1. Test Set TS-147C/UP, Block Diagram.

SECTION 2

THEORY OF OPERATION

1. GENERAL DESCRIPTION OF CIRCUITS.

a. A block diagram of the test set components and their interconnections is shown in figure 2-1. The test signals are generated by the test oscillator which is frequency modulated by the saw tooth voltage supplied by the triggered sweep generator. The sweep generator is triggered in synchronism with the system firing cycle either by means of voltage pulses connected to the TRIGGER input receptacle or by means of pulse r-f power detected and amplified by the detector crystal and trigger amplifier.

b. The output of the test oscillator is controlled directly by means of the POWER SET attenuator and the r-f cut-off. The POWER SET attenuator provides adjustment of the signal level applied to the thermistor bridge. The r-f cut-off is a wave guide switch which serves as a means for turning the output of the oscillator on or off.

c. The output level of the test signal is measured by the DBM attenuator. When the POWER SET attenuator is adjusted so the thermistor bridge is balanced, the DBM dial indicates directly the test signal power level at the RF receptacle. The step attenuator, operated by the TEST knob, sets the range of the DBM attenuator. When the TEST knob is in RECV position the DBM range is −42 to −83 dbm; for (dot) position, the DBM range is ap-

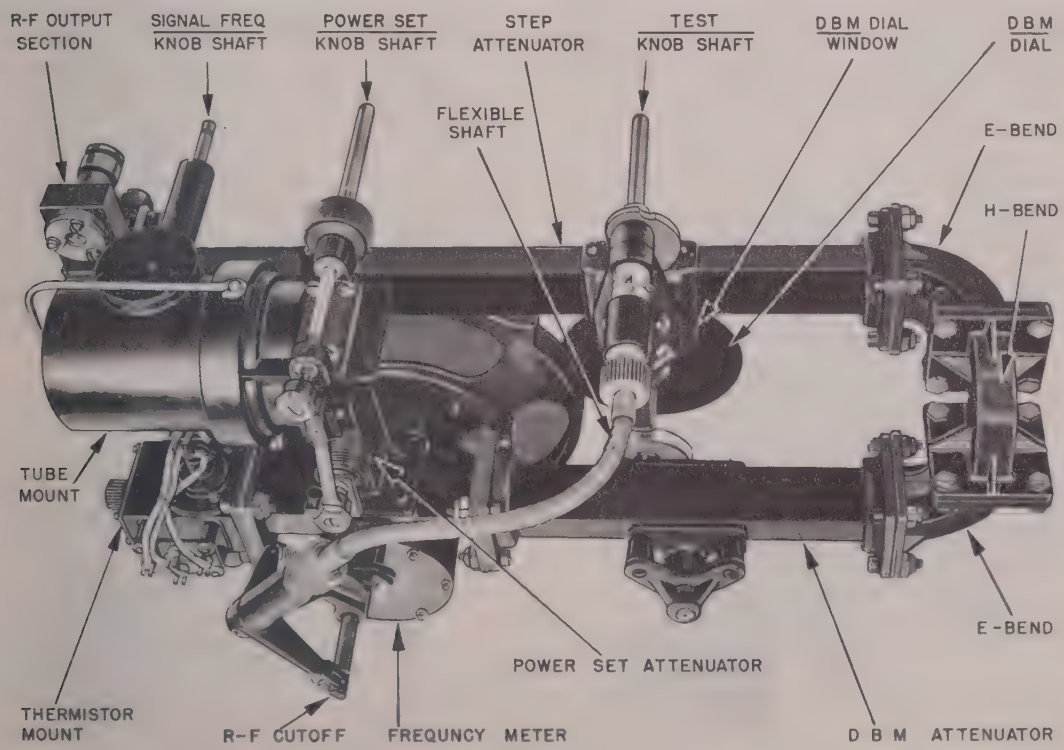


Figure 2—2. R-F Plumbing Arrangement.

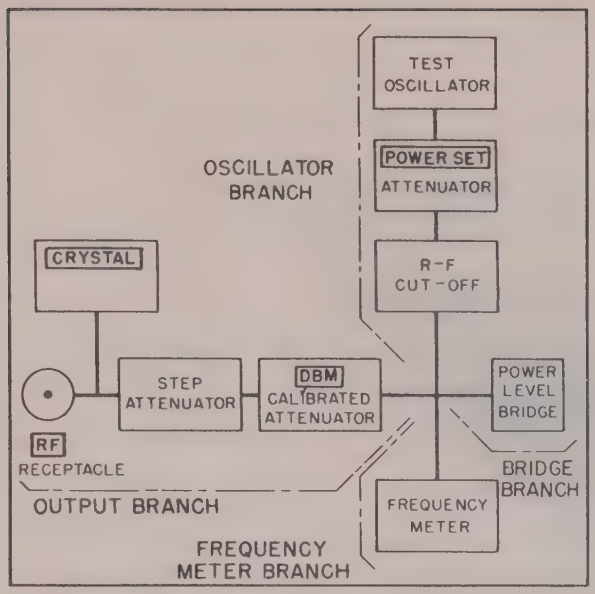


Figure 2—3. Simplified Block Diagram Showing Plumbing Branches.

proximately −7 to −30 dbm for readings of +7 to +30, but calibration for this range is approximate only.

d. The frequency of the test signal is measured by the frequency meter. When the frequency meter cavity is tuned to the test signal frequency, part of the power from the test oscillator is reflected and a dip in the bridge meter reading is produced. The reflection of the frequency meter also causes a decrease in the power output of the test set. If the test signal is frequency modulated and the frequency meter is tuned within the range of the frequency sweep, power will be absorbed at each time that the frequency sweep reaches the resonant frequency of the frequency meter. The instantaneous decrease in power output resulting from the absorption will appear as a small negative pip in the frequency response curve seen on the A-scope. See figure 1-5.

e. In addition to operating as a signal generator, the test set also measures the power and frequency of external r-f signals applied to the test set. Power is measured by means of the DBM attenuator and the thermistor bridge wattmeter. For this measurement the TEST knob is set to TRAN position to close the r-f cutoff and set the DBM attenuator range to +7 to +30 dbm. The DBM attenuator is then adjusted to decrease the input power to the level which balances the thermistor bridge wattmeter. At this point, the power level at the bridge is 1.0 milliwatt and the DBM dial indicates directly the input power level in dbm (decibels above 1.0 milliwatt).

f. Frequency of input signals is measured by the same means used for test signals. At resonance the frequency meter absorbs part of the power applied to the thermistor bridge and causes a dip in the bridge meter reading.

2. R-F PLUMBING COMPONENTS.

a. GENERAL.

(1) Figure 2-2 shows the physical layout of the r-f plumbing components in the test set. The plumbing components are wave guide sections fitted with attachments or modifications to vary the way in which r-f power is transmitted through them. Most of the components are fixed assemblies which cannot be disassembled in the field for maintenance or repair. Some components are calibrated assemblies which if taken apart in the field can no longer effect accurate measurements. In any case, however, each component is replaceable as a complete unit which can be easily removed or inserted in the set.

(2) The arrangement of the plumbing comprises three branches; namely, the input (or output) branch, the oscillator branch, and the bridge branch. The three branches join in a T-section at which junction the wavemeter is located. The three branches described are designated in figure 2-3 and will be referred to by these names in locating components in the ensuing descriptions.

(3) The component assemblies of the r-f plumbing are connected by means of a gasket-flange joint (figure 2-4). These joints replace the more familiar choke-flange

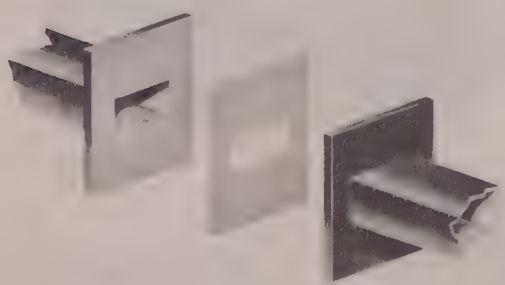


Figure 2—4. Gasket-Flange Joint.

Figure 2—5. Choke-Flange Joint.

joints (figure 2-5) used in most 3.2-cm band plumbing systems. The gasket-flange joint consists of two flanges between which is sandwiched a thin copper gasket of the same shape as the flange face. The joint is fastened by means of four screws, one through each corner of the flanges and gasket.

b. TUBE MOUNT ASSEMBLY (figures 2-6 and 2-7).

(1) The tube mount contains the test oscillator tube (V104) and the POWER SET attenuator. The mount is a section of wave guide on which is attached an octal tube socket and shield can. When the oscillator tube is inserted in the socket, the output probe of the tube projects into the wave guide and serves as an antenna to radiate r-f power down the guide. The distance from the output probe to the shorted end of the guide is effectively one-quarter wavelength so that energy radiated toward the shorted end is reflected back in phase with the energy radiated toward the output.

(2) The POWER SET attenuator adjusts the power from the test oscillator tube transmitted to the other plumbing components. The attenuator consists of a rectangular strip of glass coated with resistive material. Since the electric field strength varies from maximum at the center of the wave guide to zero at the edge, the power dissipated by the glass strip increases as the strip is moved toward the center of the guide.

(3) The metal case placed around the oscillator tube acts as an r-f shield to reduce r-f leakage from the oscillator tube from air currents which would cause variations in frequency due to change in temperature.

c. FREQUENCY METER ASSEMBLY (figures 2-8 and 2-9).

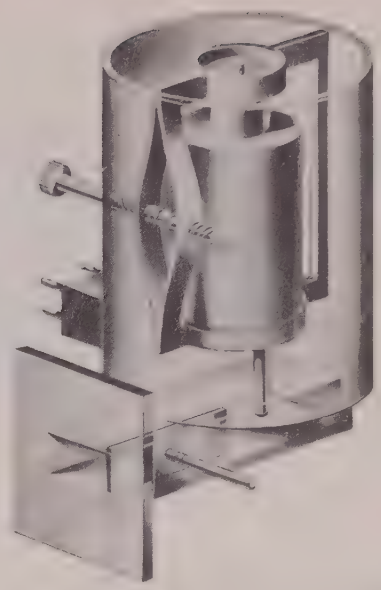


Figure 2—6. Tube Mount Assembly Simplified Phantom View.

(1) The frequency meter assembly consists of the frequency meter resonator and dial together with a T-section of wave guide which contains the r-f cut-off. The T-section connects the assembly to the three branches of the plumbing defined in figure 2-3. The r-f cut-off is a sliding door which opens and closes the opening of the oscillator branch at the junction of the T.

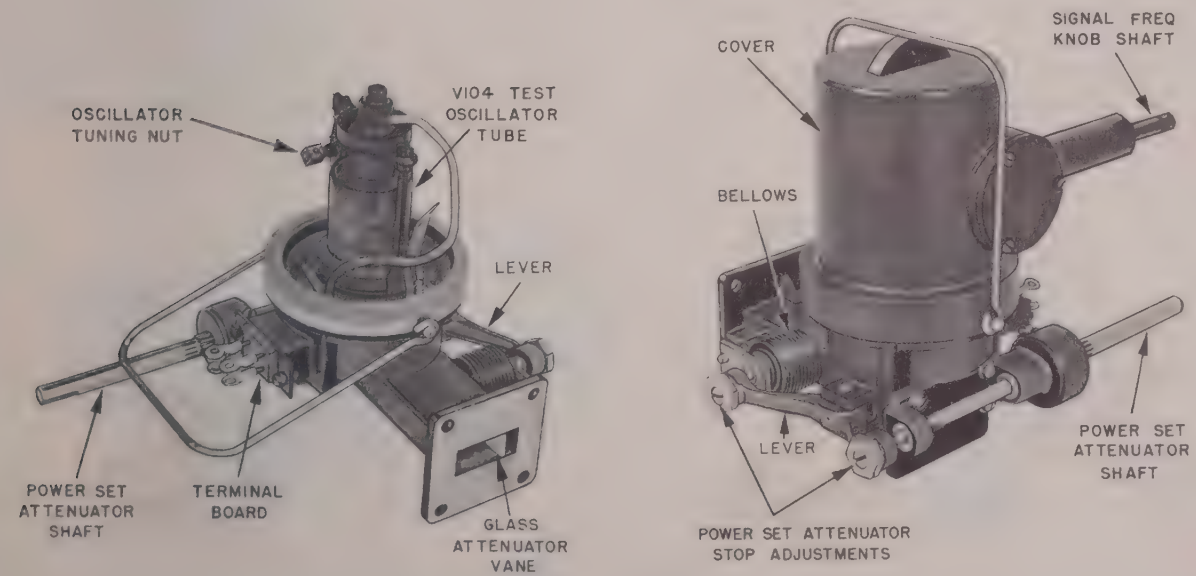


Figure 2—7. Tube Mount Assembly.

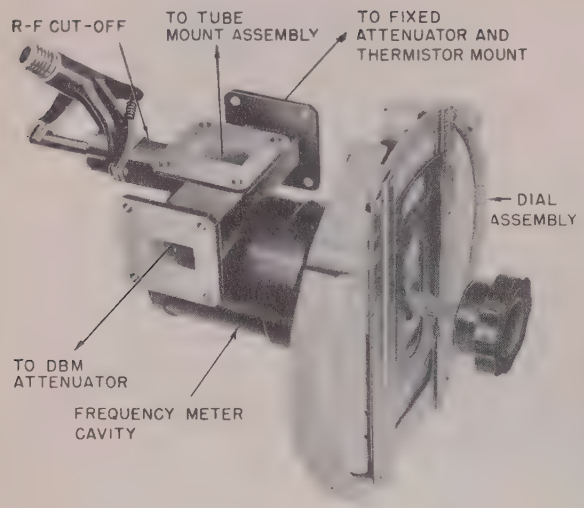


Figure 2—8. Frequency Meter Assembly.

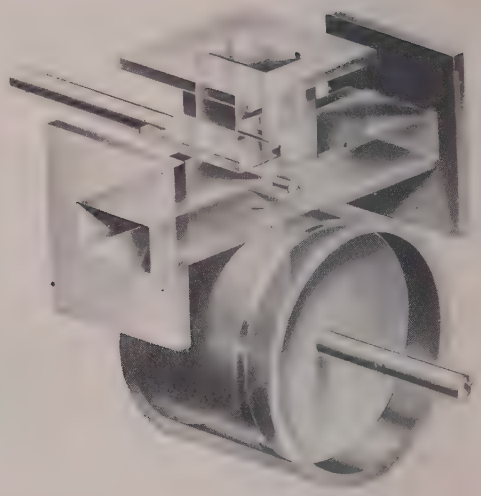


Figure 2—9. Frequency Meter Assembly Simplified Phantom View.

(2) The frequency meter is a cylindrical cavity resonator, the volume of which is adjustable by means of a plunger. The cavity is coupled to the T-section by means of a hole in the wave guide opposite the r-f cut-off. When the length of the cavity is adjusted to one-half wavelength, the cavity resonates and presents a low impedance at the hole coupling. As a result, some of the transmitted power incident on the T-section is reflected by the cavity thus causing a decrease in the power level at the thermistor bridge.

d. THERMISTOR MOUNT ASSEMBLY (figures 2-10 and 2-11).

(1) The thermistor mount is a section of wave guide which contains the thermistor element of the thermistor bridge circuit. The bead thermistor is mounted parallel to the voltage field in the wave guide. A matching stub and a shorting plug are provided to match the section impedance to the connecting plumbing components.

(2) Two disc thermistors for temperature compensation are mounted on the outside of the wave guide. These thermistors have relatively large mass and their resistance is affected principally by the ambient temperature of the thermistor mount. The operation of the thermistor bridge circuit is described in paragraph 3.*d.* of this section.

(3) The meter shunt resistor, R201, attached to the thermistor mount, changes the sensitivity of the bridge meter to correspond to the sensitivity of the thermistor bridge. This makes the thermistor mounts interchangeable

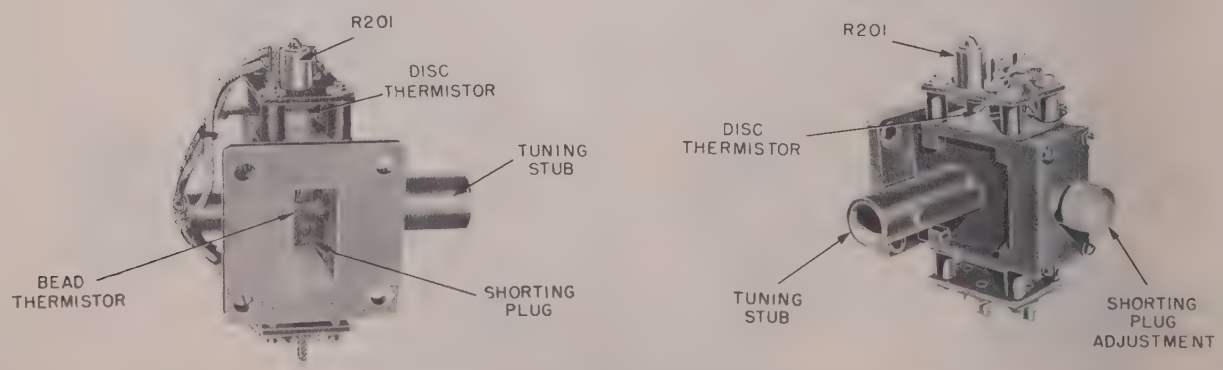


Figure 2—10. Thermistor Mount.

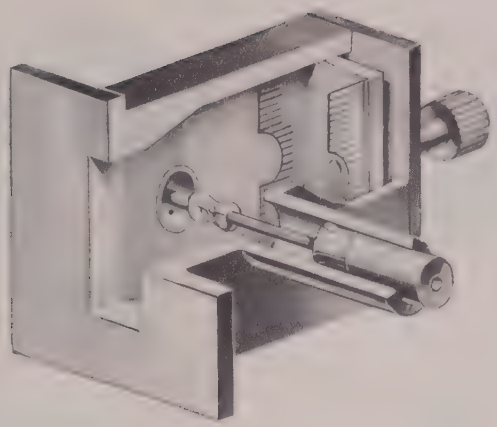


Figure 2—11. Thermistor Mount, Simplified Phantom View.

without affecting the accuracy of power measurements.

e. DBM CALIBRATED ATTENUATOR (figures 2-12 and 2-13).—The DBM attenuator is a section of wave guide which contains a movable rectangular glass vane coated with resistive material. The vane mounts on two sliding rods by means of which the position of the vane can be adjusted between the side and the center of the wave guide. The two rods are driven by a linear cylindrical cam operated by the DBM knob. The vane is parallel to the electric field in the wave guide. Since the electric field strength increases from zero at the side of the guide to a maximum at the center of the guide, the loss caused by the attenuator increases as the vane is moved towards the center of the wave guide.

f. STEP ATTENUATOR (figures 2-14 and 2-15).

(1) The step attenuator is a variable attenuator (similar to the DBM attenuator in principle) used in series with the DBM attenuator to increase the attenuation range of the test set. The step attenuator differs from the DBM attenuator in the type of cam drive used to move the glass vane across the wave guide. Instead of a linear cylindrical cam, the step attenuator uses a disc cam with three detents. Two of the detents position the cam follower and the attenuator vane for minimum attenuation. The

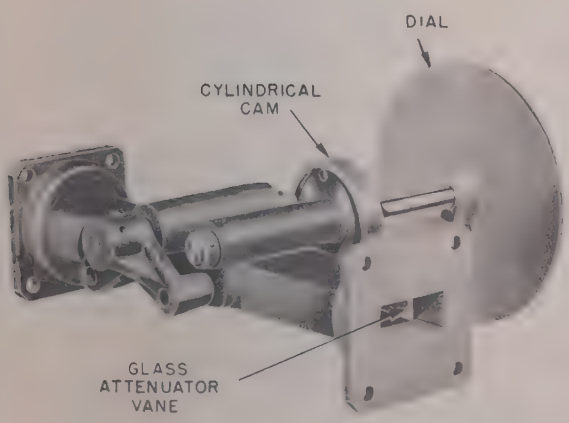


Figure 2—12. DBM Calibrated Attenuator.

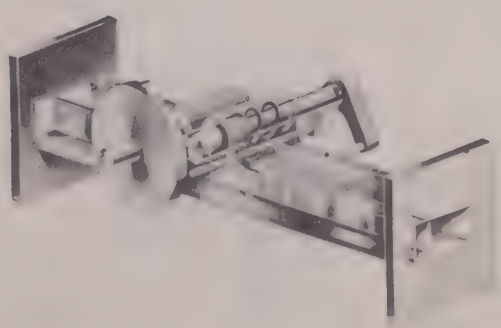


Figure 2—13. DBM Calibrated Attenuator Simplified Phantom View.

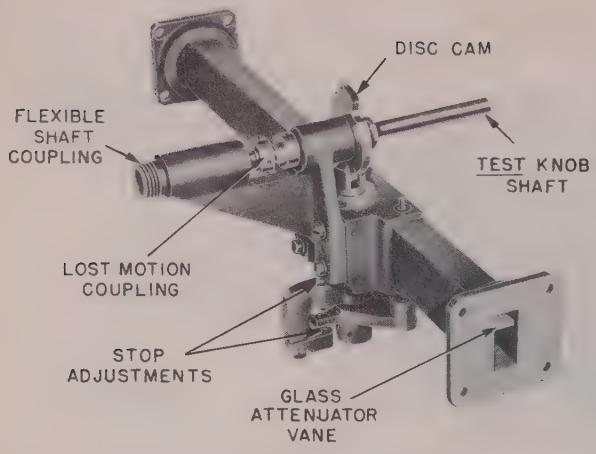


Figure 2—14. Step Attenuator.

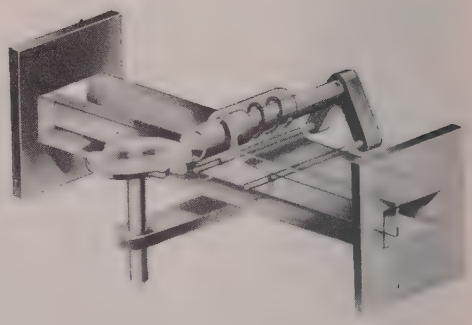


Figure 2—15. Step Attenuator Simplified Phantom View.

third detent sets the attenuation to a higher value. The resulting action produces two steps or levels of attenuation.

(2) The step attenuator cam is operated by the TEST knob. The cam is set in the minimum level detents when the TEST knob is set to the TRAN and (dot) positions. For these settings the range of the DBM dial is +7 to +30 dbm. In RECV position the TEST knob sets the cam in the third or high level detent to change the DBM range −42 to −80 dbm.

g. R-F OUTPUT AND DETECTOR SECTION (figures 2-16 and 2-17).

(1) The output section consists of a coax-to-wave guide coupling and a crystal detector. The coax coupling couples the RF receptacle to the wave guide plumbing. The center conductor of the RF receptacle projects into the wave guide and is in effect an antenna which radiates into the guide. The shorted end of the guide acts as a reflector located one-quarter wave length behind the coax probe.

(2) The crystal detector portion of the output section is another section of wave guide which is slot coupled to the main section. The secondary section is terminated by a silicon rectifier crystal capsule which detects pulse r-f power for triggering the sweep generator.

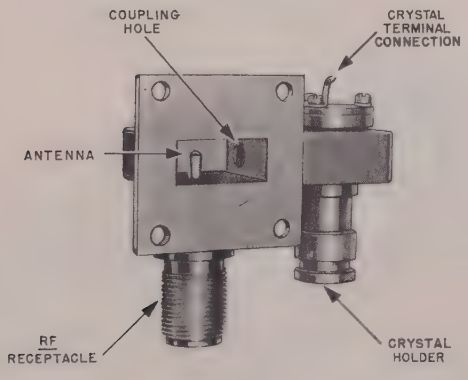


Figure 2—16. R-f Output and Detector Section.

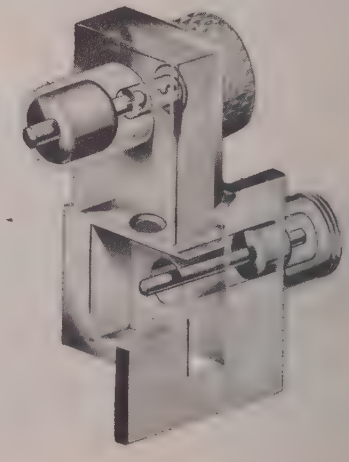


Figure 2—17. R-f Output and Detector Section Simplified Phantom View.

3. ELECTRICAL CIRCUITS.

a. TRIGGER DETECTOR AND AMPLIFIER CIRCUIT (figure 2-18).

(1) The trigger detector and amplifier circuit provides the means for triggering the frequency sweep generator from pulse r-f power applied to the RF receptacle. The r-f pulses are detected by the crystal, Y101, in the output coupling section and the resulting pulse voltage is applied to the input of the trigger amplifier. The amplifier is a three-stage resistance-coupled amplifier consisting of one and one-half 6SL7 twin triodes, V107A, B and V108A. The voltage gain is approximately 500. The output of the amplifier supplies a voltage pulse which can trigger the blocking oscillator sweep circuit. The output pulse is parallel fed through C111 to the blocking oscillator transformer, T102.

(2) Video triggers applied to the TRIGGER receptacle of the test set are amplified by the last stage of the amplifier. The voltage trigger pulses feed through C115 directly to the grid of V108A.

b. BLOCKING OSCILLATOR SWEEP CIRCUIT (figure 2-19).

(1) The frequency sweep circuit for the test oscillator is a sawtooth generator of the triggered blocking oscillator type. The blocking oscillator consists of one-half of a 6SL7 twin triode (V108B) and a three-winding transformer (T102). The circuit comprises a conventional blocking oscillator except that the grid is biased below cutoff so that a trigger pulse must be applied to start each cycle oscillation. The grid bias is applied to the cathode by the voltage divider R134 and R135.

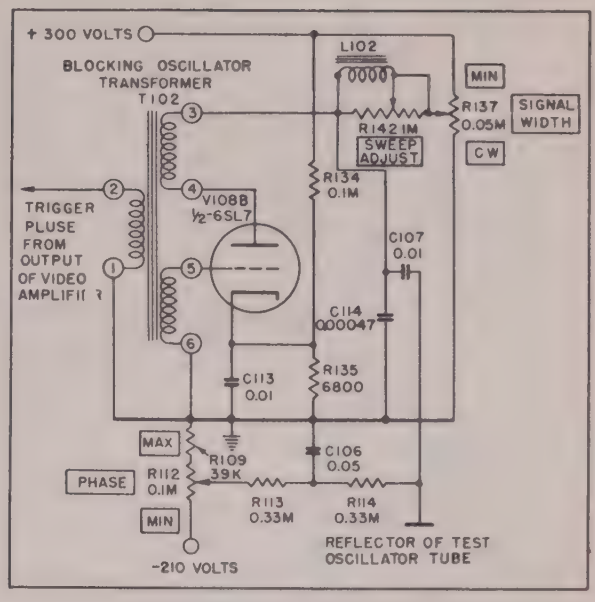


Figure 2—19. Blocking-Oscillator Sweep Circuit Simplified Schematic.

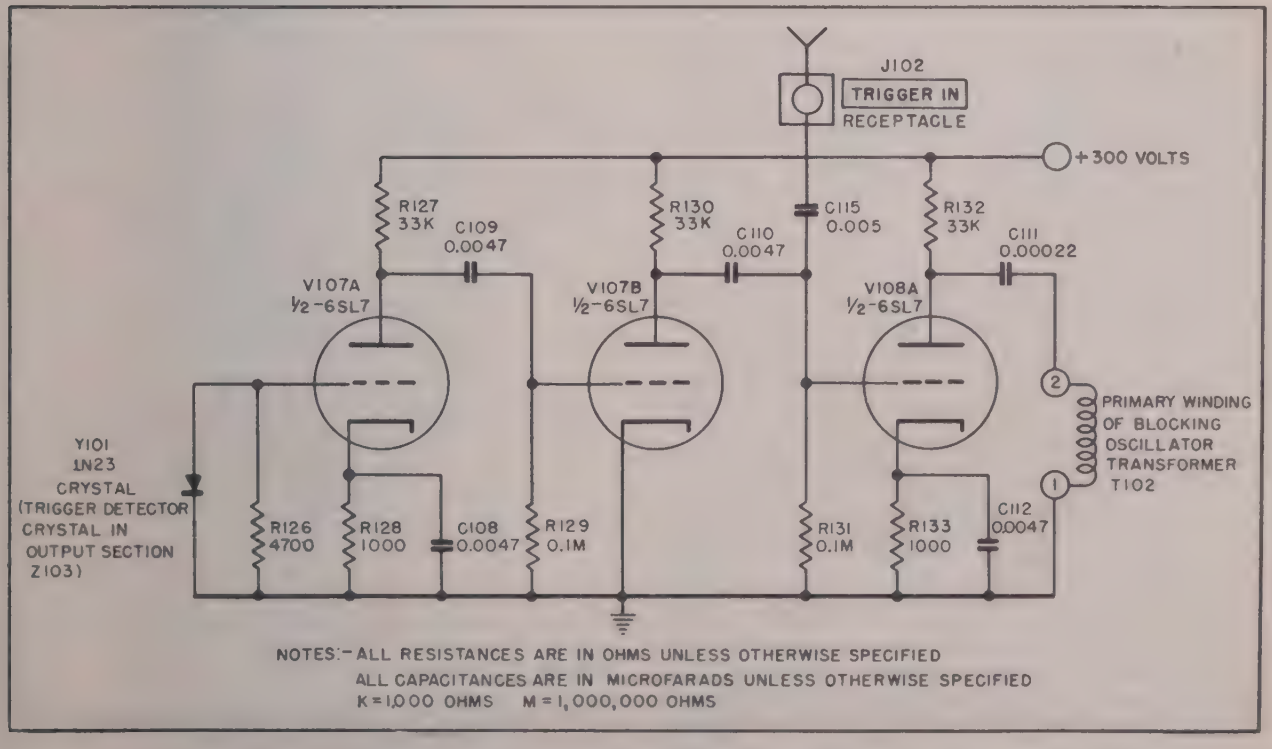


Figure 2—18. Trigger-Detector and Amplifier Circuit, Simplified Schematic.

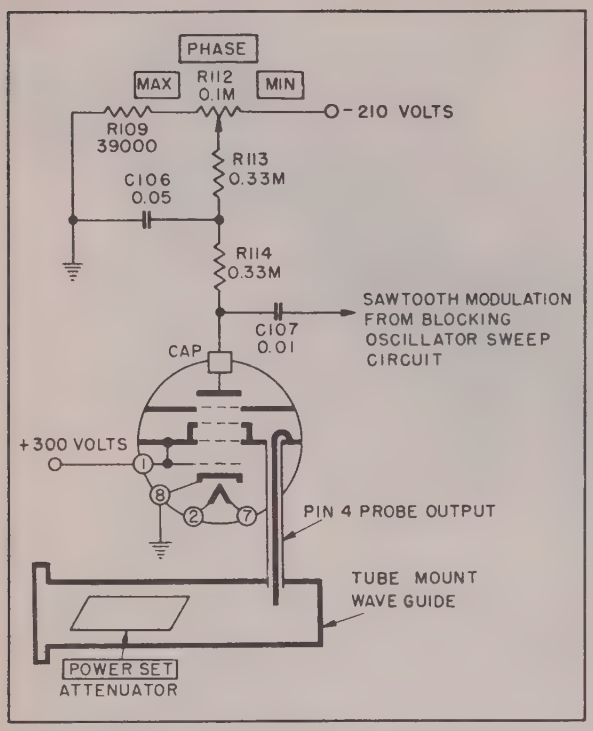


Figure 2—20. Test Oscillator Circuit Simplified Schematic.

(2) The blocking oscillator generates saw tooth pulses by discharging C114. When a trigger pulse is applied to the transformer (T102), the grid is raised above cutoff and oscillation starts. The plate current which flows during the time the grid is above cutoff causes a voltage drop across the plate resistor (R136 and part of R137). This decreases the voltage across C114 to a value below the steady state voltage. When the single cycle oscillation ceases, the plate current is zero but a voltage drop still exists in the load resistor (R136) due to the charging current of C114. This voltage decreases to zero as the condenser (C114) charges to the steady state voltage. The charging curve which occurs after the oscillation ceases is the sawtooth sweep used to modulate the test oscillator.

(3) The amplitude of the sweep voltage depends upon the steady state voltage across the condenser (C114). The voltage is made adjustable from 0 to +300v by means of the SIGNAL WIDTH potentiometer (R137). As the steady state voltage is increased by the SIGNAL WIDTH control, the amplitude of the sweep voltage is increased. The limits of the control are marked CW and MIN on the control panel. CW corresponds to zero voltage and MIN corresponds to maximum voltage. These reference marks designate the effect of the SIGNAL WIDTH control on the oscilloscope pattern obtained during receiver tests.

c. TEST OSCILLATOR CIRCUIT (figure 2-20).

(1) The test oscillator tube (V104) used in the test set is a type 2K25 reflex klystron.

(2) The reflex klystron (figure 2-21) is a velocity modulation microwave oscillator. It consists of an electron gun which produces a focused electron beam of uniform velocity, a reentrant cavity resonator tunable through the range of operating frequencies, and a reflector electrode which decelerates and returns the electron beam towards the resonator. The electrons are emitted from the cathode and are accelerated by the positive potentials on the grid and the resonator. Assuming a varying voltage on the resonator, those electrons that arrive when it is positive will be speeded up and those that arrive when it is negative will be slowed down. This results in a "bunching" of electrons into spaced groups as they proceed down the tube. Arriving near the reflector, which is maintained at a negative potential, they are repelled. If this voltage is correctly adjusted, they will be reflected back to the resonator when the voltage on it is such that the electron bunches are slowed down and so deliver energy to the resonator. Energy is taken from the tube by a coaxial probe which is terminated in the resonant cavity by a loop.

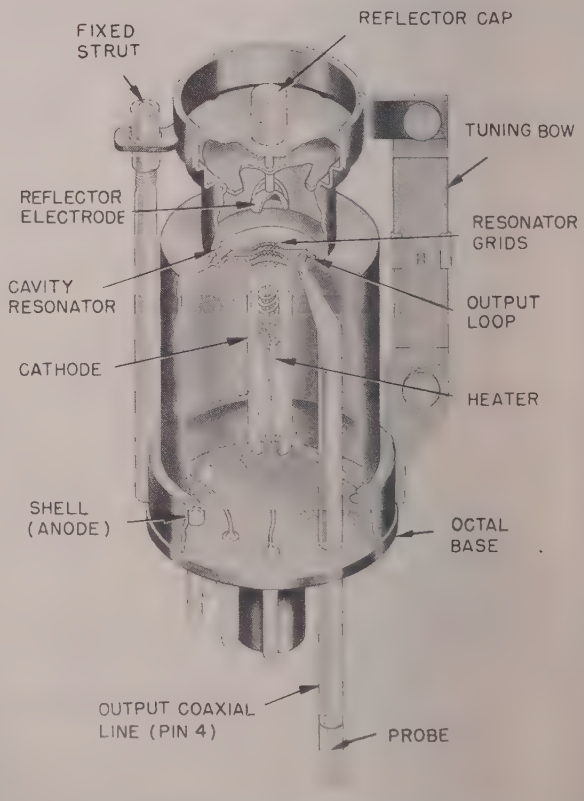


Figure 2—21. Test Oscillator Tube Cut-away View.

When the tube is placed in the socket of the tube mount, the coaxial probe extends into the tube mount wave guide and acts as an antenna to radiate power.

(3) There are two methods for tuning a reflex klystron tube. The tube can be tuned mechanically by varying the volume of the resonator cavity and spacing of the resonator grids. Decreasing the distance between the grids increases the capacitance of the resonant cavity, thereby decreasing the natural frequency of oscillation. This mechanical tuning is accomplished by turning the square headed nut mounted on the tube. The tuning range is covered by approximately $3\frac{1}{2}$ turns of the knob and allows a variation of approximately plus or minus six percent about a specified frequency.

(4) The second method of tuning the oscillator is by varying the reflector voltage. At only one value of reflector voltage will the transit time of the electrons be correct to enable oscillation at the natural resonant frequency of the resonator cavity. If the reflector voltage is varied slightly, the rate at which electron bundles will arrive at the resonator cavity will change. The tube will not stop oscillating immediately, but will shift slightly in frequency to compensate for the change in transit time. Varying the reflector voltage thus causes the frequency of the oscillator to be swept over a range or approximately 25 to 75 megacycles.

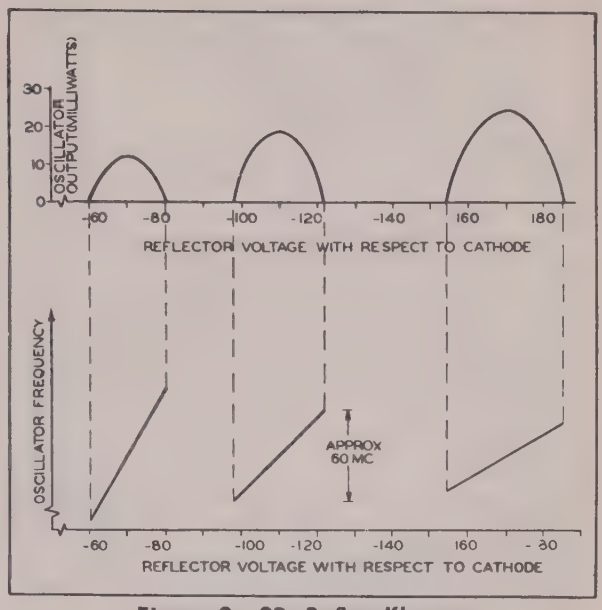


Figure 2—22. Reflex Klystron Characteristics.

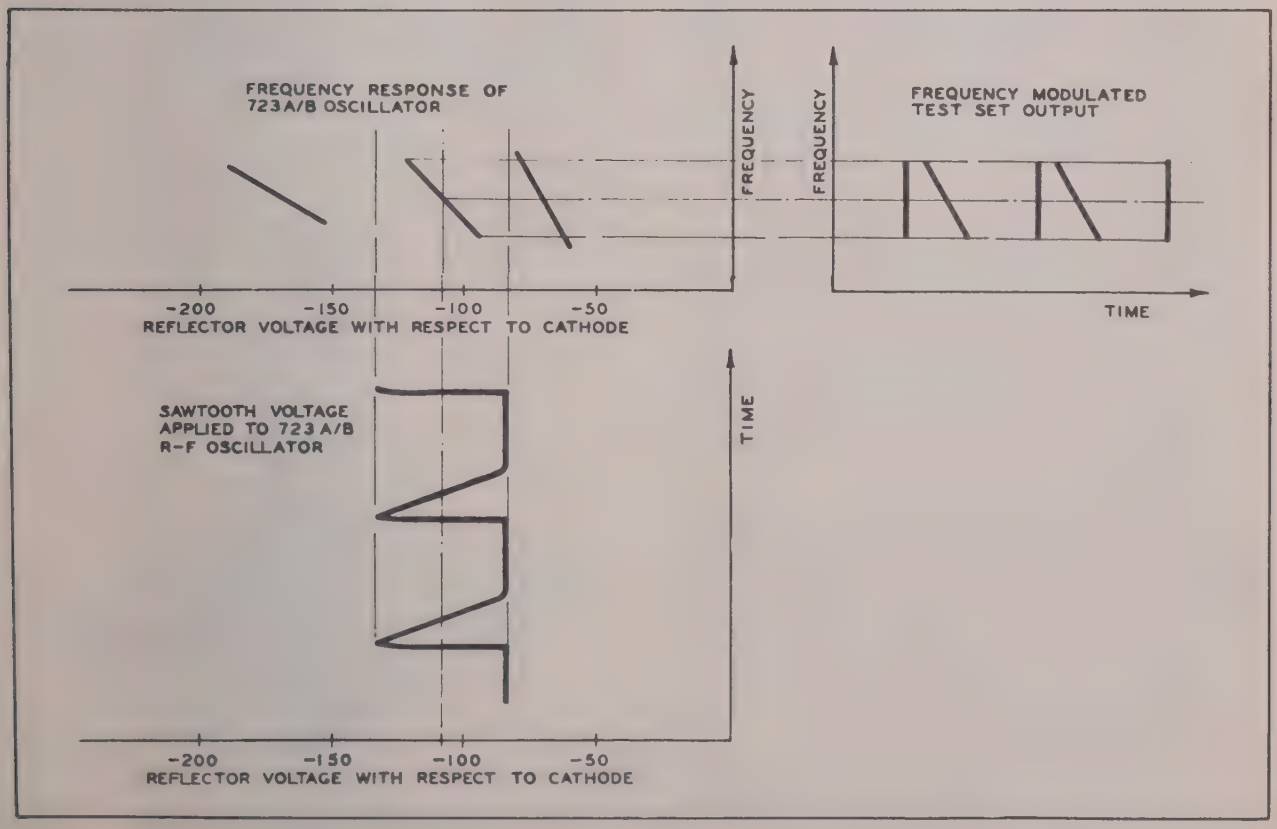


Figure 2—23. Test Oscillator Modulation.

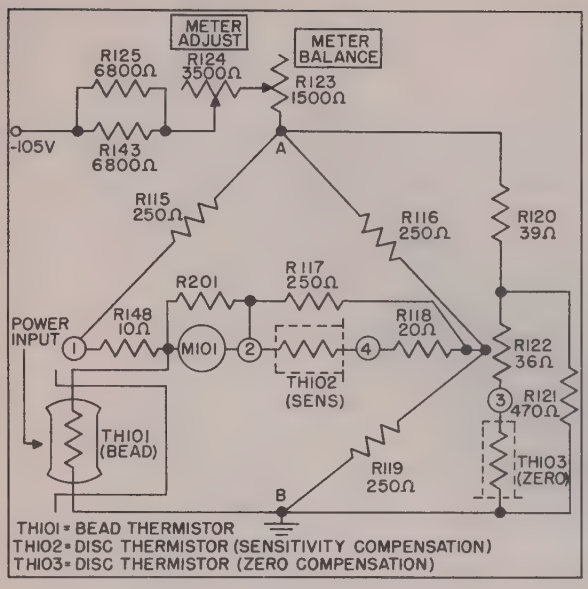


Figure 2—24. Complete Thermistor Bridge Circuit.

(5) As reflector voltage is varied, the tube will oscillate in different modes, the four lowest corresponding roughly to reflector voltages of minus 30, minus 75, minus 110, and minus 170 volts with respect to the cathode. The relation of power output and frequency to reflector voltage is shown for three modes in figure 2-23. These curves are not precise for any one tube and indicate only average characteristics of the type 2K25 tube. The curves indicate that the power output of the tube is greater in the modes with more negative reflector voltages. The range of frequency sweep within each mode decreases with increasingly negative reflector voltages. Between the half power points of the minus 75-volt mode, the frequency variation is approximately 60 megacycles. In the 110-volt mode, the frequency range is approximately 35 megacycles, and in the 170-volt mode approximately 25 megacycles. Frequency data for the 30-volt mode have not been determined accurately.

(6) Figure 2-23 shows how the frequency of the test oscillator tube is modulated by varying the reflector voltage. If the sawtooth voltage is applied to the reflector about the center value of 100 volts (d-c level) as shown, the frequency of the oscillator will be swept through one or more modes and the power output will be frequency modulated. The number of modes covered depends upon the amplitude of the sawtooth. This is determined by the setting of the SIGNAL WIDTH control.

(7) When the d-c level of the sawtooth is changed to a lower voltage, the sawtooth will sweep over a lower mode. Also the time at which the center frequency of the mode is reached occurs later. Such a change appears as a shift in the position of the frequency response curve along the range axis of the A-scope. The d-c level of the sawtooth is controlled by the PHASE control.

d. THERMISTOR BRIDGE CIRCUIT (figure 2-24).

(1) GENERAL.—The thermistor bridge wattmeter is a Wheatstone bridge which measures the resistance of an r-f power sensitive resistor called a thermistor. The thermistor has a negative temperature coefficient of resistance, i.e., as the temperature is increased the resistance decreases. The temperature, and therefore the resistance, of the thermistor is determined by the temperature of its environment, by the current flowing through it, and by absorbed r-f power. If the current and ambient temperature conditions are properly controlled, r-f power can be measured by measuring the change in thermistor resistance caused by the applied power.

(2) BASIC BRIDGE CIRCUIT (figure 2-27).

(a) There are two types of thermistors used in the test set. The bead thermistor (see figure 2-25), used for power measurement, has a small mass and is affected by the four changes mentioned above. The disc thermistor (figure 2-26), used in compensating networks, has a large mass. Its resistance is relatively insensitive to the current flowing through it and is dependent primarily on the ambient temperature. A simplified thermistor bridge circuit is shown in figure 2-27. The Wheatstone bridge consists of three resistors (R115, R116, and R118) and the bead thermistor in the thermistor mount. When the Wheatstone bridge is balanced, no current flows in the

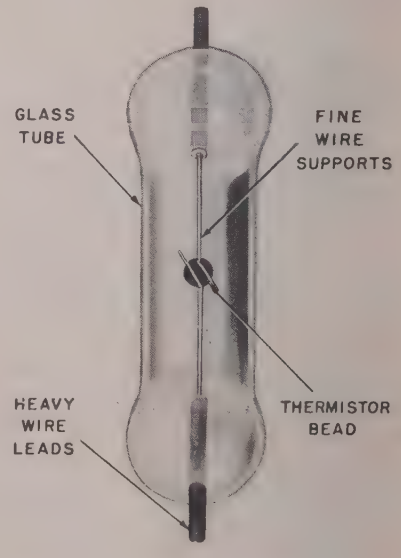


Figure 2—25. Bead Thermistor Bridge Circuit.

meter. The bridge is balanced when the resistance meets the following condition:

$$\text{resistance of thermistor} = \text{R115}\ \frac{\text{R119}}{\text{R116}}$$

(b) In the test set, the bridge is designed so that it will balance when one milliwatt of r-f power is applied to the bead thermistor. This is done by adjusting the initial thermistor resistance so that, when one milliwatt of power is applied, the resistance decreases just enough to balance the bridge.

(c) The initial setting of the thermistor resistance is made by adjusting the current through it. This is accomplished by the METER BALANCE potentiometer (R123). The constants of the bridge are chosen so that the required initial value of thermistor resistance produces 150 $\mu\alpha$ through the meter. This current is marked BALANCE on the meter scale.

(d) The initial adjustment of current is referred to as "balancing" the meter because when the adjustment is made, the meter reads BALANCE. It must be realized, however, that in this condition the bridge is *unbalanced* by a known amount. Balance of the bridge is not attained until the meter current is reduced to zero by applying one milliwatt of power to the bead thermistor. The zero current point on the meter scale is marked SET POWER.

(e) This basic thermistor bridge circuit, shown in figure 2-27, must be modified in practical operation to overcome two disadvantages. Means are employed to compensate for the fact that the meter sensitivity (microamperes of meter current per milliwatt of r-f power) varies with temperature and that because of changes in the bead thermistor ambient temperature, the METER BALANCE control must be readjusted before every measurement. The methods employed to compensate for these disadvantages are outlined below.

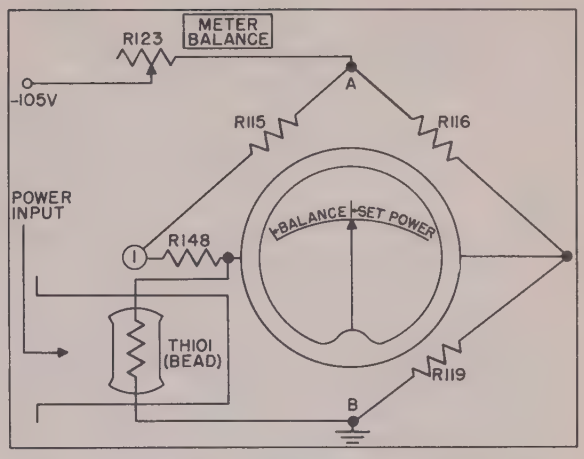


Figure 2—27. Basic Thermistor Bridge Circuit.

(3) SENSITIVITY COMPENSATION (figure 2-28).

(a) The thermistor bridge shown in figure 2-27 increases in sensitivity with decrease in temperature. The sensitivity (ohms/watt) of the thermistor bead remains constant over a broad temperature range, but the bridge sensitivity (microamperes meter reading per milliwatts r-f power) increases with decrease in temperature. As the temperature goes down, the thermistor resistance tends to go up, making it necessary to apply a higher voltage to the bridge by adjusting the METER BALANCE control (R123). Because of this higher voltage, the change in the current through the meter, due to a given change in thermistor resistance, is greater at lower temperature.

(b) This variation in sensitivity can be compensated for by increasing the meter resistance as the temperature decreases. Since thermistors have this characteristic of

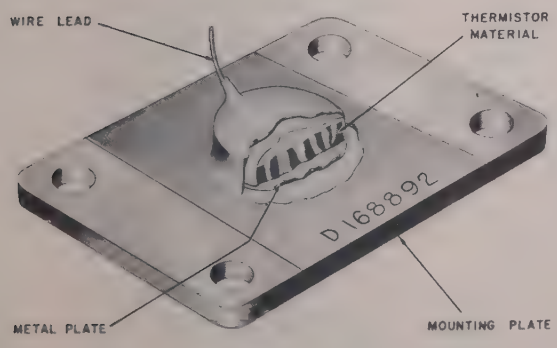


Figure 2—26. Disc Thermistor.

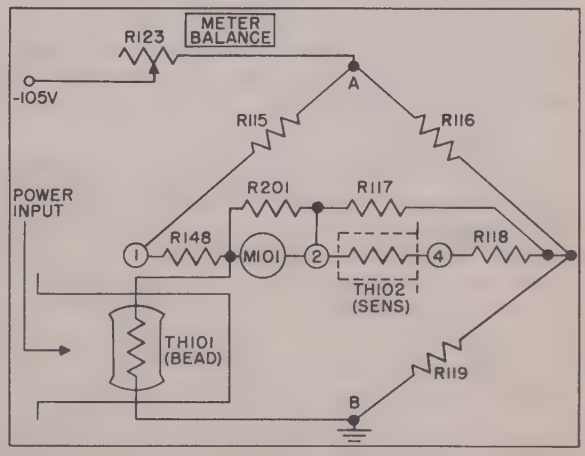


Figure 2—28. Basic Thermistor Bridge Circuit with Sensitivity Compensation.

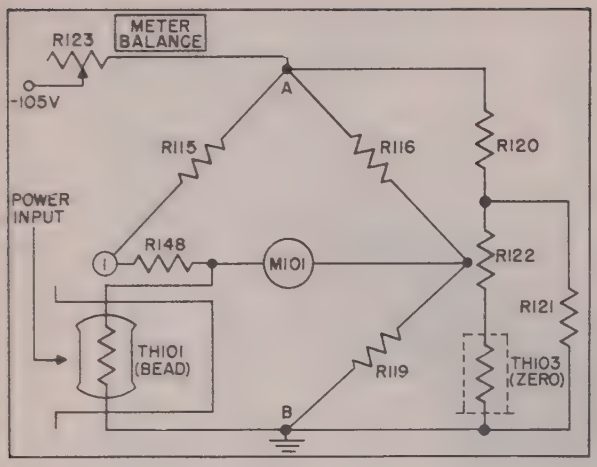


Figure 2—29. Basic Thermistor Bridge Circuit with Zero Compensation.

increase in resistance with decrease in temperature, a disc thermistor is placed in series with the meter. (See figure 2-28.) It is necessary to put resistance R118 in series and resistance R117 in parallel with the disc thermistor to obtain the correct rate of change of resistance with temperature so that the sensitivity of the bridge remains constant over the required temperature range.

(4) ZERO DRIFT COMPENSATION (figure 2-29).

(a) To eliminate frequent resetting of the METER BALANCE control, an automatic method is provided for increasing the current through the bead thermistor with decrease in temperature. A disc thermistor whose resistance increases with decreasing temperature is placed in parallel with the bridge. (See figure 2-29.) Since more current flows through the bridge at lower temperature, the ratio of the resistance of the shunting disc thermistor to the resistance of the bridge (across points A and B) is greater at lower temperature.

(b) To adjust this compensation to cover the required temperature range, the disc thermistor is combined in a net work with resistances R120, R121, and R122.

(5) COMPENSATED BRIDGE CIRCUIT (figure 2-24).

(a) The thermistor bridge used in the test set has both sensitivity compensation and zero drift compensation.

(b) Resistance, R124 (METER ADJUST), is added in series with the METER BALANCE potentiometer (R123) to adjust the range of METER BALANCE control to suit the particular thermistor mount in the test set.

(c) The compensating networks are designed for an average bead thermistor so that the compensation is correct at 0°C, 30°C, and 60°C. At intermediate points, the compensation is not exact although it is satisfactory for practical use. These networks are not perfect for any bead thermistor due to the variation in electrical characteristics of bead thermistors. As a result, the manual METER BALANCE control cannot be eliminated entirely.

4. POWER SUPPLY CIRCUIT.

a. The power supply provides +300 volts and −210 volts to the electrical circuits of the test set. The power supply consists of a full wave rectifier V101, an electronic regulator, and a V-R tube regulator. The rectifier supplies about 550 volts d-c ungrounded through a choke input L-filter. The two regulators act as a voltage divider, the center tap of which is grounded. The electronic regulator on the positive side of ground regulates and filters the +300 volt supply. The V-R tube regulator on the negative side of ground regulates the −210 volt supply and provides negative bias for the amplifier tube in the electronic regulator.

b. The electronic regulator consists of a regulator tube (V102) which controls the output voltage directly, and an amplifier tube (V103) which controls the grid voltage on the regulator tube. The amplifier tube (V103) is connected as a d-c amplifier to amplify any voltage variations in the regulator output. The amplified variations when applied to the control grid of the regulator tube (V102) cause the regulator tube to change its voltage drop in a direction which compensates for the variations.

c. The V-R tube regulator consists of two OC3/VR105 tubes (V105 and V106) in series. In normal operation each tube maintains a constant voltage drop of 105 volts so that the total voltage across the two in series is 210 volts. The 105-volt drop across V105 is used to supply the thermistor bridge circuit. The total voltage (210V) of the two tubes forms the d-c reflector voltage supply for the test oscillator tube (V104).

SECTION 3

INSTALLATION

1. SCOPE OF THIS SECTION.

Procedures for setting up Test Set TS-147C/UP for operation are given in this section; actual operation procedures are given in Section IV.

2. UNPACKING THE EQUIPMENT.

a. GENERAL.

Unpack the equipment observing the following precautions. Do not tear the waterproof liner. Open it carefully so that it can be used again. For the same reason use a nail puller or other suitable tool for removing the nails in the shipping case cover, so that the cover is not broken up. Upon removing the equipment from the shipping case, it is advisable to put the silica gel and waterproof liner back in the shipping case and to retain the case for use in re-shipping the equipment.

b. MECHANICAL CHECK.

The equipment should be inspected for possible damage or disarrangement during shipment. Check to see that no nuts, washers, bits of solder or other foreign particles have become lodged where they might cause a short circuit. Tighten any screws or nuts which may have worked loose. A careful search should also be made for broken wires and loose connections since a detailed mechanical inspection at this time may save much inconvenience in the long run. All mechanical controls should be operated in each alternate position or through their full range of travel in order to detect any bent shafts or other evidences of abnormal operation. Also check to see that all tubes are well seated in their sockets, that all tube shields are firmly in place and that fuses F-101 and F-102 are in their holders.

3. DIMENSIONAL DATA.

(See figure 3-1.)

Dimensional data given in the referenced figure can be used for estimating space requirements in the variety of operating locations afforded by Test Set TS-147C/UP. These include operations in various field and depot stations and are also useful in planning storage or transportation facilities for the equipment.

4. POWER REQUIREMENTS.

Test Set TS-147C/UP is operated with an external power source rated at 115v AC single phase, 50 to 1600 cycle. Power consumption of the equipment is approximately 125 watts at 115 volts, 60 cycles.

5. INSTALLATION.

Test Set TS-147C/UP is a portable instrument which requires no installation or special adjustments before it is connected to a power supply, and put in operation. When making connections, the operator should arrange the equipment so that it is possible to operate the test set controls and observe the patterns on the oscilloscope screen while making adjustments on the radar system. Take off cover of test set and remove chassis from case. The chassis is retained in the case by five captive screw fasteners on the control panel. Inspect the test set chassis for damaged tubes and components. Make certain that no tubes are missing and that all tubes are completely in their proper sockets.

6. INITIAL ADJUSTMENTS.

Before installing the equipment the following test operations should be performed.

a. Turn the SIGNAL FREQ shaft to see that the coupling end turns the tuning nut on the oscillator tube.

b. Examine the bridge meter for damage. If the meter needle stands deflected from the ZERO SET line adjust the ZERO SET screw until the deflection is reduced to zero.

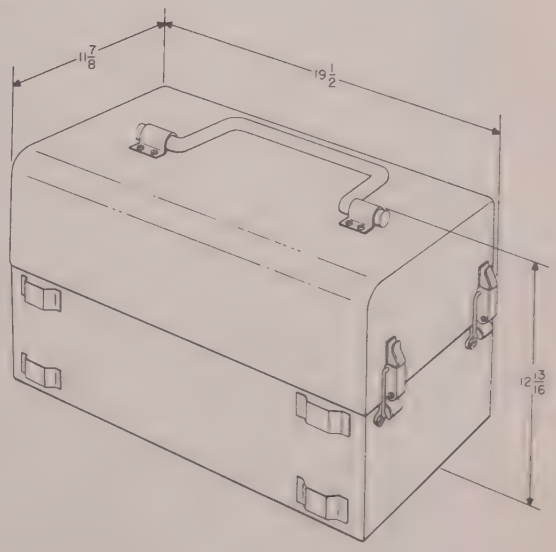


Figure 3—1. Test Set TS-147C/UP Dimensional Drawing.

c. Connect the test set to a 115v (50 to 1600 cycle) power source.

d. Turn ON-OFF switch to ON and allow approximately one or two minutes for the test set to warm up.

e. During warm up time the dial lamps for the DBM and FREQ. dials should light. Also tubes V-105 and V-106 should glow steadily and the needle of the bridge meter should deflect from the SET POWER point.

f. After warm up is complete turn the TEST knob to TRAN and adjust the METER BALANCE knob until the meter reads BALANCE. If this adjustment cannot be made properly then adjust the METER ADJUST potentiometer according to the instructions in Section VII par. 5.

g. Make the following control settings:

CONTROL	SETTINGS
SIGNAL WIDTH	Full clockwise (CW)
PHASE	Full counterclockwise (MIN)
TEST	RECV
POWER SET	Full counterclockwise
SIGNAL FREQ	Middle of range.

h. Turn the PHASE control slowly clockwise until the meter needle deflects to the right from the BALANCE point. This indicates that the oscillator tube is oscillating. Adjust the PHASE control for a maximum deflection then turn the POWER SET knob clockwise to limit the deflection to the SET POWER point.

i. Continue to turn the PHASE control slowly clockwise until the needle drops back to BALANCE position and then deflects again toward SET POWER. There should be at least three separate positions of the PHASE control where the meter needle deflects to indicate oscillation.

j. Adjust the PHASE control for the peak of the largest of the several deflections. Adjust the POWER SET knob to set the meter needle to the highest on-scale reading that is practical to use. Turn the FREQUENCY knob fully counterclockwise.

k. Very slowly turn the FREQUENCY knob clockwise until a dip is produced in the meter deflection. Adjustment of FREQUENCY knob to obtain this dip is very sharp and must be performed very carefully in order to locate it.

l. If the test set passes the above test satisfactorily replace the chassis into the case and fasten the five captive screw fasteners.

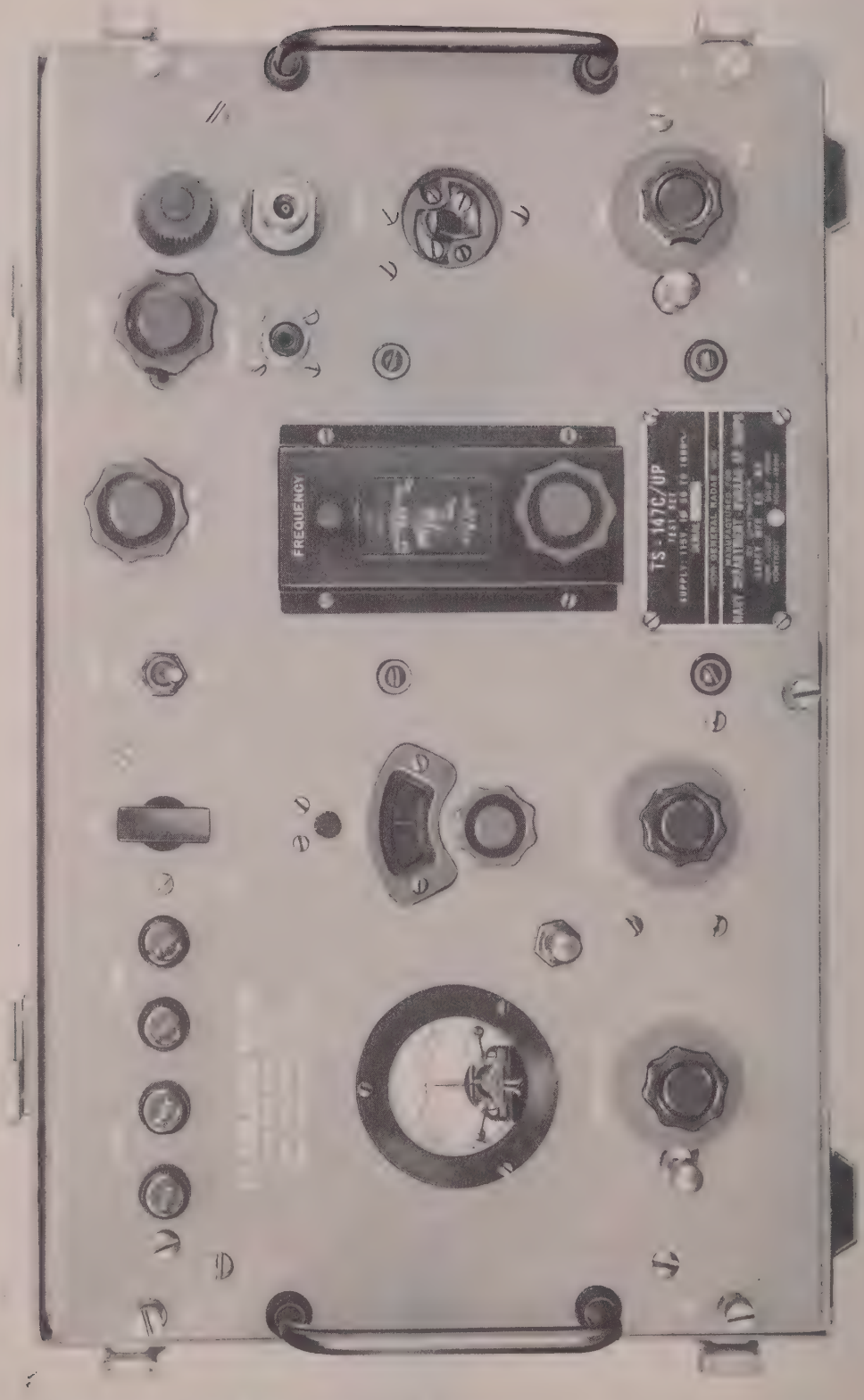


Figure 4—1. Test Set TS-147C/UP, Equipment Controls and Receptacles.

SECTION 4

OPERATION

1. INTRODUCTION.

a. Test Set TS-147C/UP is a microwave signal generator which supplies frequency modulated and CW test signals and measures power and frequency.

b. The signal generator consists essentially of a reflex klystron oscillator (2K25) and a trigger sweep generator which can modulate the frequency of the klystron by applying a saw-tooth voltage to the reflector of the tube. The sweep can be triggered either by r-f pulses supplied to the r-f receptacle or by voltage pulses applied to the TRIGGER receptacle of the test set.

c. Frequency modulated pulses are produced by an internal saw-tooth sweep which can be varied to produce frequency excursions from zero (CW) to at least 60 mc by changing the sweep amplitude. At maximum amplitude the sweep voltage covers three modes of the klystron. On the A-scope each mode covered appears as a sharp pip. The pips can be widened by decreasing the sweep amplitude. Changing the DC level of the sweep changes the position of the test signals along the range axis of the A-scope. Test Signals can be seen on all types of radar indicators as artificial signals.

d. Average power measurements are made by a temperature compensated thermistor bridge wattmeter and a calibrated r-f attenuator. The test sets can measure both the power level of the test signals generated internally and the power level of external signal levels applied to the test set. Power is measured in decibels relative to one milliwatt over a range of −42 to −83 dbm for peak levels of test signals supplied by the set and +7 to +30 for average levels of external power applied to the test set. These measurements are accurate within 2.0 db. The ranges stated give levels at the RF input-output connection on the test set and in use, the attenuation of cables and coupling devices must be added to these levels.

e. Frequency measurements are made by an absorption frequency meter which uses the thermistor bridge wattmeter as a tuning indicator. When tuned to resonance, the frequency meter reflects part of the power so that a dip in the wattmeter indication is observed. The range of the frequency meter is 8500 to 9600 mc. It is accurate to within $2\frac{1}{2}$ mc over this range. The frequency difference between any two signals not more than 60 mc apart can be measured to within ± 1.0 mc. The frequency meter is calibrated to within ± 1.0 mc at 9310 mc. The frequency meter can be used both for test signals generated in the test set and external power applied to the test set.

2. EQUIPMENT CONTROLS AND RECEPTACLES.

(See figure 4-1.)

The operating controls and receptacles of the Test Set TS-147C/UP are all located on the front panel. The function of each control and receptacle is briefly described by an adjacent panel marking. In the following sub-paragraphs the panel markings and legend are explained and the applicable symbol designation is given in parenthesis after the legend for aid in identifying the circuit component.

a. ON-OFF switch (S-101). The ON-OFF switch is located in the top center of the front panel of the test set. With the switch in the ON position 115V AC power is applied to the power transformer to start the test set. At the same time, with the switch in the ON position the test set heater is OFF. With the ON-OFF switch in the OFF position the test set is off but the heater is ON.

b. METER BALANCE (R-123). METER BALANCE control R-123 adjusts the current through the thermistor, to set the bridge meter reading to BALANCE. The DBM dial must be set to maximum attenuation and TEST knob must be set to TRAN when adjustment is made.

c. DBM (calibrated output attenuator). This control permits the measurement of average level transmitter power in decibels above one milliwatt (TEST knob must be set to TRAN position), and also measures peak power level of test signal output in decibels below one milliwatt (TEST knob must be set to RECV position).

d. TEST (function selector). In the TRAN position the function selector sets the range of DBM for transmitter power measurements (+7 to +30 dbm scale). It also cuts off the test signals. In the RECV position the function selector turns on the test signal and sets the range of dbm for measuring power at low level test signal output for receiver testing (−40 to −83 dbm scale).

e. FREQUENCY (absorption frequency meter). This control tunes the frequency meter to resonance at the frequency being measured. In order to make the proper conversion the dial reading should be multiplied by 10 to obtain a frequency in megacycles.

f. PHASE CONTROL (R-113). This potentiometer controls the DC reflector voltage on the test oscillator tube. For CW operation it selects the operating mode for the test oscillator. For FM operation it adjusts the time delay between the trigger and center frequency of test signal. It also shifts the position of the response curve along the horizontal axis of the oscilloscope.

g. POWER SET. This control adjusts the initial power level of the test signal to balance bridge.

h. SIGNAL FREQ. This control tunes the test signal to the desired frequency.

i. SIGNAL WIDTH (R-137). This potentiometer controls the rate and deviation of the test signal frequency modulation. It also controls the width of the pattern on the oscilloscope.

3. CONNECTIONS.

a. Use of the test set in the full scope of its applications requires four connections:

(1) Power must be supplied to operate the test set. For this connection use Power Cord CX-337/U connected to the 115V AC receptacle on the test set panel. The test set operates on 115 volts (± 10%), 50 to 1600 cycle power.

(2) R-f coupling must be made between the test set and the radar system. For this connection use R-F Cable CG-92A/U connected to the RF receptacle on the test set panel. Either Pick-up Horn AT-68/UP or the directional coupler can be used to couple the cable to the radar system.

(3) Trigger for the test set sweep generator is required when the f-m test signals are to be used. A trigger is supplied by the r-f pulses applied to the RF receptacle without any additional connections or by any standard video trigger, such as IFF trigger, applied to the TRIGGER receptacle of the test set by means of the Trigger Cable CG-638/U.

(4) An oscilloscope (TS-34/AP series or TS-239/AP series) connected to the video output of the radar receiver is used to indicate the response of the system by A-scan.

b. The first two connections, (1) and (2), are always required; connection (3) is necessary for tests on radar receivers. Complete connections are shown in figures 4-2 and 4-3.

Note

For many tests, the radar system indicator is satisfactory in place of the separate A-scope. An A-scope *is* necessary, however, for measuring receiver bandwidth and recovery time.

4. MEASURING RADAR PERFORMANCE.

Note

Each primary subdivision of this paragraph, i.e., *4a. 4b. 4c.* etc. is complete in itself or contains all necessary references to previous tests.

a. PRELIMINARY PROCEDURE.

(1) PREPARE RADAR. – Turn radar on, observe modulator current, rectifier current, and crystal current. Leave radar spinner stationary.

(2) PREPARE TS-147C/UP.

(a) SET CONTROLS:

Control	*Setting*
TEST	TRAN
DBM	All the way counter-clockwise

(b) CONNECT TEST SET.—Make power, r-f, and trigger (if needed) connection specified in paragraph 3.

(3) PREPARE OSCILLOSCOPE (not used if radar has A or J-Scope).—Use TS-34/AP series, TS-239/AP series or equivalent oscilloscope with sweep length of 50 to 100 microseconds.

(a) TS-34/AP.—Turn POWER ON; set to NORMAL; SWEEP SELECTOR to START-STOP; SWEEP SPEED to MED; INPUT IMPEDANCE to HIGH; ATTENUATION to 20 db. Switch to EXT SYNC and connect radar trigger to EXT SYNC (or use INT SYNC). Connect radar video signal to SIGNAL INPUT (TS-34/AP). Adjust INPUT IMPEDANCE and ATTENUATION for convenient signal height. Adjust SYNC VOLTAGE for steady signals (check SYNC POLARITY).

(b) TS-239/AP.—Set controls to equivalent settings.

b. MEASURING TRANSMITTER AVERAGE POWER (P_{av}).

(1) CONNECT TS-147C/UP TO RADAR.—Connect R-f Cable CG-92A/U from RF receptacle to radar directional coupler (or test horn) as in figure 4-2 (or 4-3). Set TEST knob to TRAN and set DBM knob all the way counter-clockwise.

(2) TURN ON TS-147C/UP.—Connect 115V AC receptacle to power line with Power Cord CX-377/U. Turn 115V AC switch to ON and wait two minutes.

(3) BALANCE METER. – With TEST to TRAN and DBM full counter-clockwise, adjust METER BALANCE until meter is at BALANCE.

(4) SET POWER.—Turn DBM dial clockwise, reducing attenuation until meter pointer is below SET POWER. Detune FREQUENCY meter. Set meter to SET POWER by turning DBM dial counter-clockwise to take up backlash. Read DBM dial and record.

(5) COMPUTE TRANSMITTER AVERAGE POWER (P_{av}).—Compute as follows:

$$P_{av\,(dbm)} = + T^1_{(dbm)} + A_{(db)} + C_{(db)}.$$

$P_{av\,(dbm)}$ = Transmitter Average Power (in decibels above one milliwatt).

$T^1_{(dbm)}$ = Average r-f power entering the test set (in dbm). Reading of DBM dial in step (4).

$A_{(db)}$ = Total attenuation of cable and external attenuators (if any) between test set and directional coupler (or horn) in decibels. See paragraph *7.11.b.* for r-f cable calibration.

$C_{(db)}$ = Coupling of directional coupler in decibels (or space loss between radar antenna and horn).

(6) COMPARE WITH RATED P_{av}.—Compare the measured value of transmitter average power (P_{av}) with the rated value. If the rated value is not given in dbm, convert to dbm by use of figure 4-8. If the rated peak power is known, compute rated average power by procedure of paragraph *4.g.*(2).

c. MEASURING TRANSMITTER FREQUENCY (f_t).

(1) OBTAIN POWER INDICATION.—Perform the following operations, if not already performed.

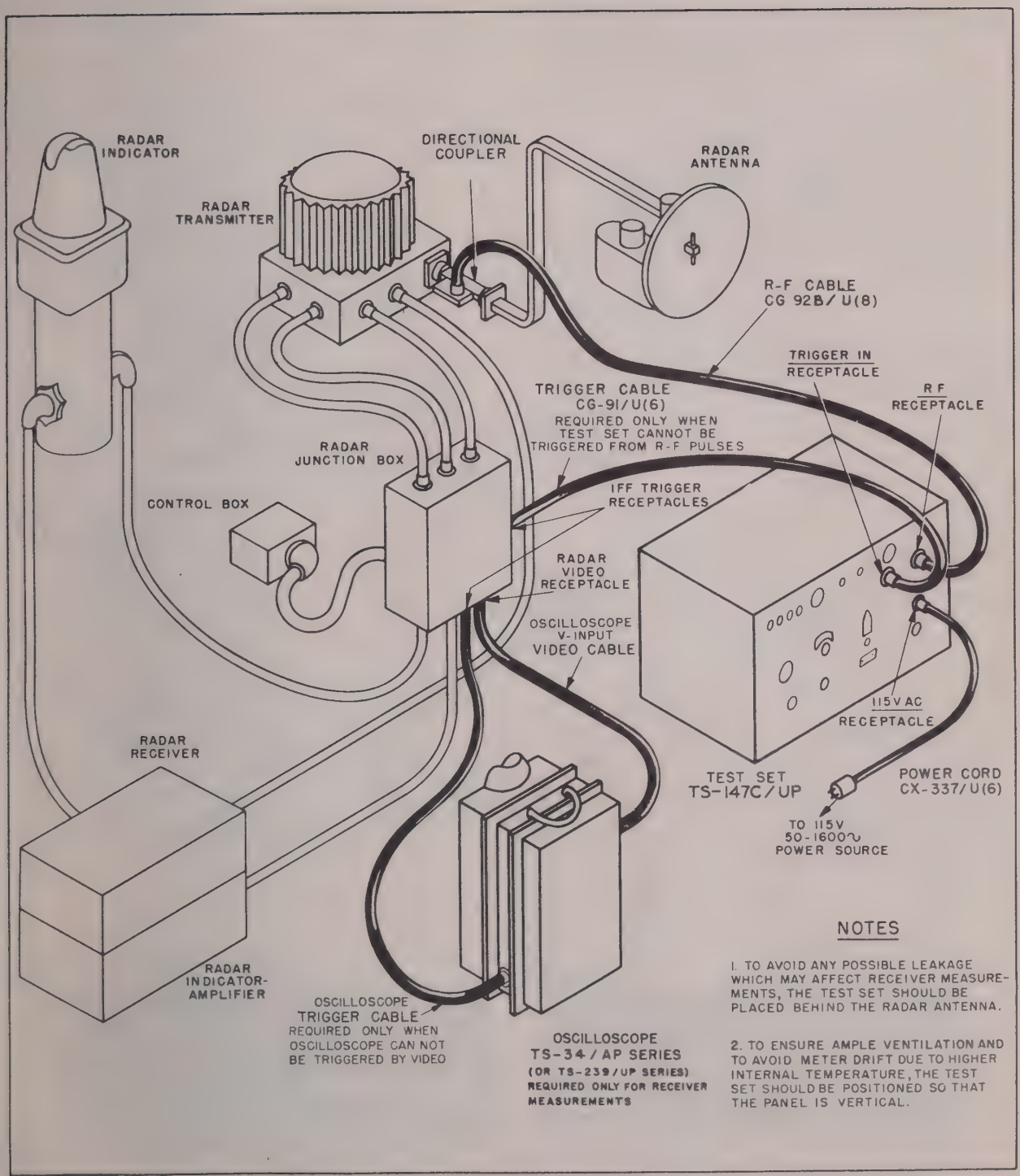

RADAR INDICATOR
DIRECTIONAL COUPLER
RADAR ANTENNA
RADAR TRANSMITTER
R-F CABLE CG 92B/U(8)
TRIGGER IN RECEPTACLE
TRIGGER CABLE CG-91/U(6)
REQUIRED ONLY WHEN TEST SET CANNOT BE TRIGGERED FROM R-F PULSES
R F RECEPTACLE
RADAR JUNCTION BOX
IFF TRIGGER RECEPTACLES
CONTROL BOX
RADAR VIDEO RECEPTACLE
OSCILLOSCOPE V-INPUT VIDEO CABLE
115 V AC RECEPTACLE
RADAR RECEIVER
TEST SET TS-147C/UP
POWER CORD CX-337/U(6)
TO 115V 50-1600~ POWER SOURCE
RADAR INDICATOR-AMPLIFIER
OSCILLOSCOPE TRIGGER CABLE
REQUIRED ONLY WHEN OSCILLOSCOPE CAN NOT BE TRIGGERED BY VIDEO
OSCILLOSCOPE TS-34/AP SERIES
(OR TS-239/UP SERIES)
REQUIRED ONLY FOR RECEIVER MEASUREMENTS
NOTES
1. TO AVOID ANY POSSIBLE LEAKAGE WHICH MAY AFFECT RECEIVER MEASUREMENTS, THE TEST SET SHOULD BE PLACED BEHIND THE RADAR ANTENNA.
2. TO ENSURE AMPLE VENTILATION AND TO AVOID METER DRIFT DUE TO HIGHER INTERNAL TEMPERATURE, THE TEST SET SHOULD BE POSITIONED SO THAT THE PANEL IS VERTICAL.

Figure 4—2. Complete Connections Using Directional Coupler.

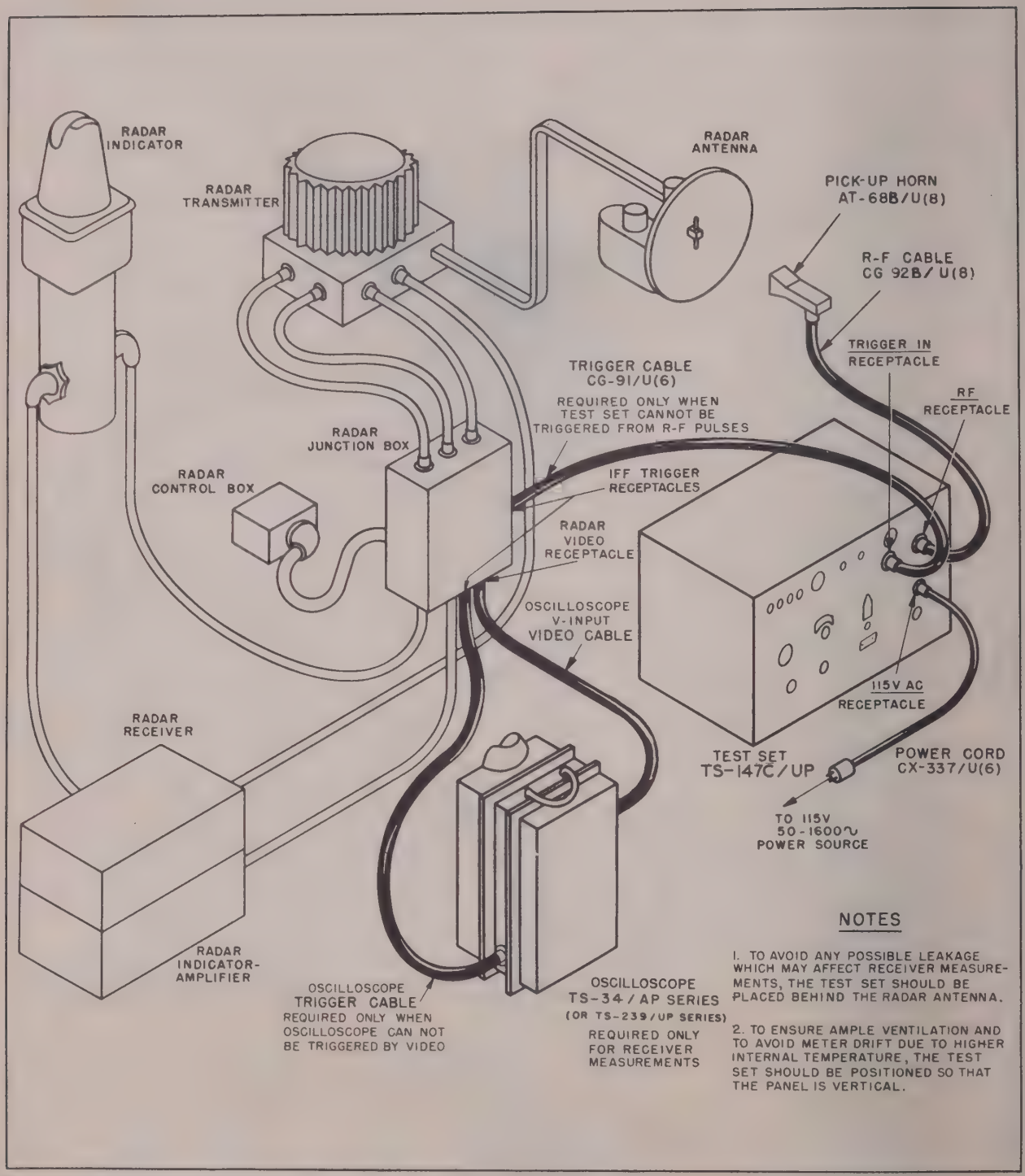

RADAR INDICATOR
RADAR TRANSMITTER
RADAR ANTENNA
PICK-UP HORN AT-68B/U(8)
R-F CABLE CG 92B/U(8)
TRIGGER IN RECEPTACLE
RF RECEPTACLE
TRIGGER CABLE CG-91/U(6)
REQUIRED ONLY WHEN TEST SET CANNOT BE TRIGGERED FROM R-F PULSES
RADAR JUNCTION BOX
RADAR CONTROL BOX
IFF TRIGGER RECEPTACLES
RADAR VIDEO RECEPTACLE
OSCILLOSCOPE V-INPUT VIDEO CABLE
115V AC RECEPTACLE
RADAR RECEIVER
TEST SET TS-147C/UP
POWER CORD CX-337/U(6)
TO 115V 50-1600~ POWER SOURCE
RADAR INDICATOR-AMPLIFIER
OSCILLOSCOPE TRIGGER CABLE
REQUIRED ONLY WHEN OSCILLOSCOPE CAN NOT BE TRIGGERED BY VIDEO
OSCILLOSCOPE TS-34/AP SERIES
(OR TS-239/UP SERIES)
REQUIRED ONLY FOR RECEIVER MEASUREMENTS
NOTES
1. TO AVOID ANY POSSIBLE LEAKAGE WHICH MAY AFFECT RECEIVER MEASUREMENTS, THE TEST SET SHOULD BE PLACED BEHIND THE RADAR ANTENNA.
2. TO ENSURE AMPLE VENTILATION AND TO AVOID METER DRIFT DUE TO HIGHER INTERNAL TEMPERATURE, THE TEST SET SHOULD BE POSITIONED SO THAT THE PANEL IS VERTICAL.

Figure 4—3. Complete Connections Using Pick-Up Horn.

Operation	*Paragraph*
Connect TS-147C/UP to Radar	*4.b.*(1)
Turn on TS-147C/UP	*4.b.*(2)
Balance Meter	*4.b.*(3)
Set Power	*4.b.*(4)

(2) OBSERVE FREQUENCY.–Tune FREQUENCY knob for dip in meter. Carefully set to maximum dip, turning FREQUENCY knob counter-clockwise to avoid backlash. Record reading and multiply by ten to convert to megacycles.

CAUTION

A SECONDARY MODE IS PRESENT AT ABOUT HALF THE DIAL FROM THE PRIMARY MODE IN THE FREQUENCY METER CHARACTERISTIC. THE SECONDARY MODE GIVES A MUCH SMALLER DIP AND IS APPROXIMATELY FOUR TIMES AS WIDE. IT SHOULD BE AVOIDED WHEN MEASURING FREQUENCIES NEAR THE LIMITS OF THE FREQUENCY METER RANGE.

d. MEASURING RECEIVER FREQUENCY.

(1) PREPARE RADAR, TEST SET, AND OSCILLOSCOPE.–Perform the following operations, if not already performed.

Operation	*Paragraph*
Prepare Radar	*4.a.*(1)
Prepare TS-147C/UP	*4.a.*(2)
Prepare Oscilloscope	*4.a.*(3)

(2) ADJUST RADAR RECEIVER. – Leave Automatic Frequency Control on (if operative), set gain high enough to show small grass on A-scope and J-scope.

(3) TUNE TEST SET TO RECEIVER.

(a) SET TS-147C/UP FOR TUNING.–Set TEST knob to (dot) position between TRAN and RCVR; DBM knob to about +15 dbm; POWER SET knob near maximum (clockwise); PHASE knob near mid position.

(b) OBTAIN FM SIGNAL. – Set SIGNAL WIDTH knob to MIN. Adjust SIGNAL FREQ knob for maximum signal; set TEST knob to RCVR and adjust DBM knob to prevent saturation (see figure 4-2 A). Proceed to step (5) unless no signal is obtained over the SIGNAL FREQ range.

(4) TUNE RECEIVER (if no test signals and test set is known to be operating properly).–Maximize crystal current with local oscillator manual reflector voltage control. Adjust coupling, if necessary, to obtain crystal current.Tune for maximum target signals or echo box signal and simultaneous maximum crystal current with local oscillator mechanical tuning. Readjust reflector voltage when necessary to obtain crystal current. Then tune test set to receiver as in step (3). If no target signals can be observed, tune receiver with test set, see paragraph *4.k* page 4-12 (or use an echo box).

(5) MEASURE f_r.

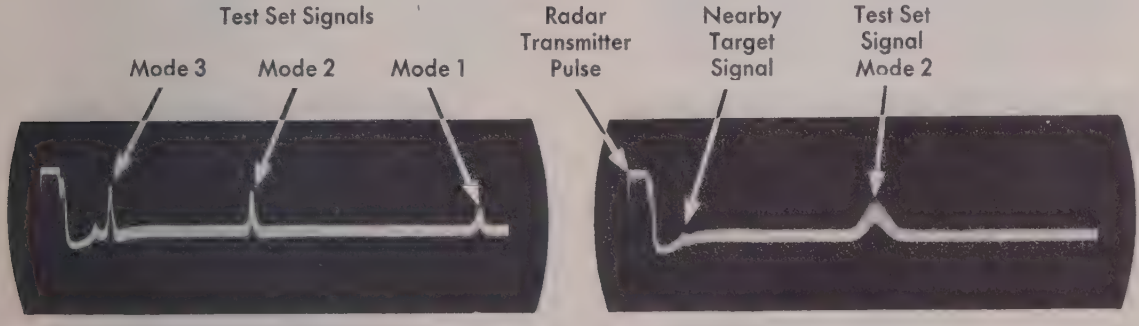
(a) OBTAIN BANDPASS CURVE.–Turn SIGNAL WIDTH knob toward center to obtain bandpass curve. Adjust PHASE knob to hold pattern on oscilloscope screen. (See figure 4-4 B.)

(b) OBSERVE FREQUENCY. – Adjust FREQUENCY control so that pip is on top of bandpass curve. (See figure 4-5 A.) Record reading and multiply by ten. If f_r differs from f_t (or beacon), by twice the radar intermediate frequency, repeat paragraph *4d.* (3) and select the alternative signal (clockwise rotation of SIGNAL FREQ decreases frequency). If the frequency differs from transmitter (or beacon) frequency other than twice intermediate frequency, it would indicate AFC troubles. Look for defects in the following:

1. L. O. Tuning (see *4.k.*).
2. Discriminator tuning.
3. AFC circuit.
4. Shock excitation of first i-f stage (AFC).
5. Bad spectrum.

e. MEASURING BANDWIDTH.

(1) OBTAIN BANDPASS CURVE.–Perform the following operations, if not already performed:



A–Narrow FM Signals, SIGNAL WIDTH at MIN.

B–Bandpass Curve, SIGNAL WIDTH near Center of Range

Figure 4—4. Frequency Modulated Test Set Signals.

Operation	*Paragraph*
Prepare Radar, Test Set, and Oscilloscope	*4.d.*(1)
Adjust Radar Receiver	*4.d.*(2)
Tune Test Set to Receiver	*4.d.*(3)
Tune Receiver (When necessary)	*4.d.*(4)
Measure Receiver Frequency	*4.d.*(5)

(2) MEASURE BANDWIDTH.—(See figure 4-5.)

(a) OBTAIN HALF POWER HEIGHT. – Increase the setting of DBM attenuator by 3.0 db, detune FREQUENCY meter, and mark half power height. Restore DBM to original setting.

(b) MEASURE FREQUENCY DIFFERENCE.– Move the FREQUENCY meter pip across the curve, observing the readings at the two points where it goes through the half power line determined in *(a)*.

Bandwidth, $B = f_1 - f_2$.

Note

Sometimes when the frequency meter pip is tuned within the passband, the response curve on the oscilloscope is so distorted that it is difficult to set the positions of frequency meter pip to the half-power points with sufficient accuracy. An alternative procedure, to be used when this condition occurs, is to calibrate the horizontal sweep in megacycles-per-inch and measure directly the distance, and hence the frequency, between the two half-power points. The sweep calibration can be made by observing the distance the frequency meter dip moves when tuned over a definite frequency range. This calibration is dependent on the setting of the SIGNAL WIDTH knob and the PHASE knob, therefore, the setting of these knobs must not be changed after the calibration is made.

f. MEASURING RECEIVER PERFORMANCE FIGURE P_m (SENSITIVITY).—If receiver is not known to

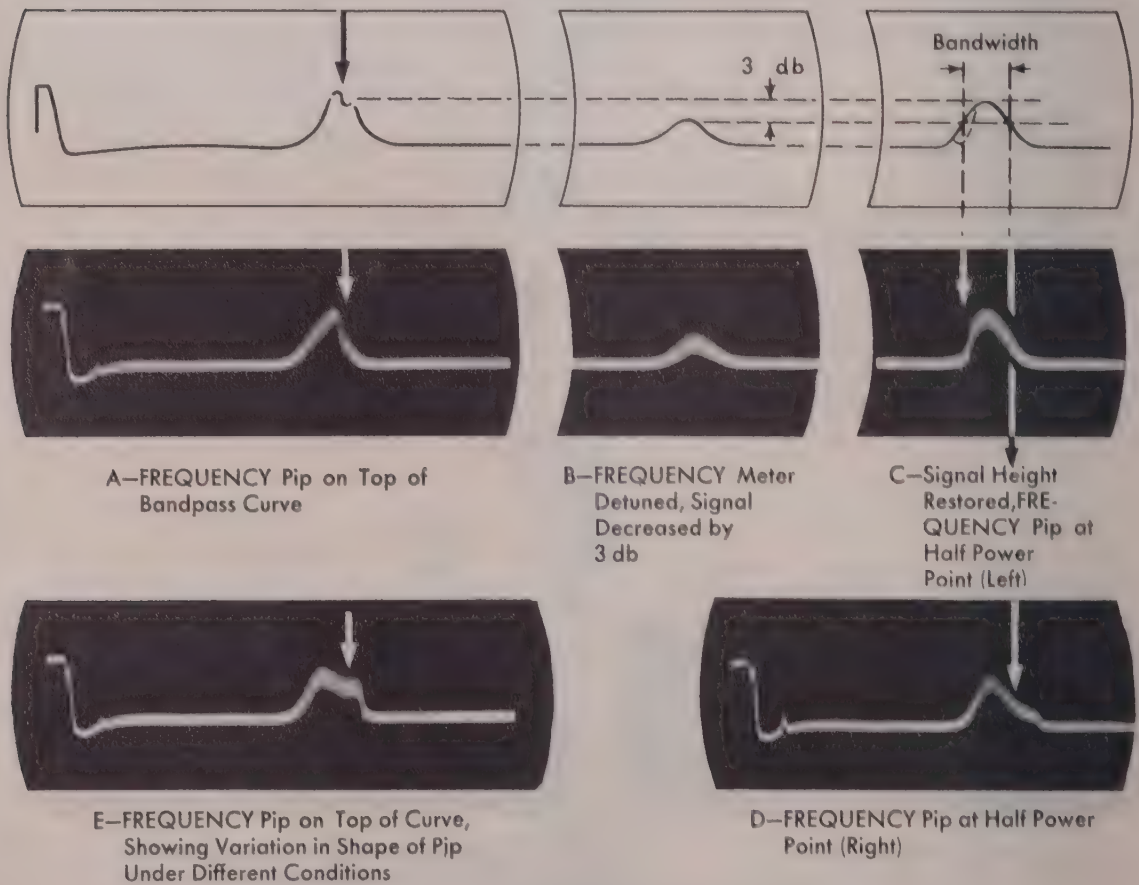

3 db
Bandwidth
A—FREQUENCY Pip on Top of Bandpass Curve
B—FREQUENCY Meter Detuned, Signal Decreased by 3 db
C—Signal Height Restored, FREQUENCY Pip at Half Power Point (Left)
E—FREQUENCY Pip on Top of Curve, Showing Variation in Shape of Pip Under Different Conditions
D—FREQUENCY Pip at Half Power Point (Right)

Figure 4—5. Receiver Frequency and Bandwidth Measurements.

be tuned to transmitter, first check receiver frequency by following paragraph *4.d.*

(1) PREPARE RADAR, TEST SET, AND OSCILLOSCOPE.—Perform the following operations, if not already performed:

Operation	*Paragraph*
Prepare Radar	*4.a.*(1)
Prepare TS-147C/UP	*4.a.*(2)
Prepare Oscilloscope	*4.a.*(3)

(2) ADJUST RADAR RECEIVER. — Leave Automatic Frequency Control on (if operative), set gain to show grass one-half of transmitter pulse or saturated signal amplitude.

(3) TUNE TEST SET TO RECEIVER.

(a) SET TS-147C/UP FOR RCVR TEST.—Set TEST knob to RCVR; DBM knob to about +15 dbm; POWER SET knob near maximum (clockwise); PHASE knob near mid position.

(b) OBTAIN FM SIGNAL. — Set SIGNAL WIDTH knob to MIN. Adjust SIGNAL FREQ. knob for maximum signal, adjusting DBM knob to prevent saturation (see figure 4-4 A). If no test set signal can be obtained, set TEST knob to (dot) position to deliver a higher level test signal to the receiver. If still no test signal is found, tune receiver by procedure of paragraph *4.d.*(4).

(4) CHECK METER BALANCE.—Set TEST to TRAN; DBM full counter-clockwise; then adjust METER BALANCE until meter is at BALANCE.

(5) FIND SIGNAL AGAIN.—Set TEST to RECV, turn DBM clockwise to find f-m signal again.

(6) SET SIGNAL POWER ON C-W. — Broaden bandpass curve to maximum by turning SIGNAL WIDTH knob clockwise to CW, while holding pattern on screen with PHASE knob. Detune FREQUENCY meter. Adjust POWER SET knob so that meter reads SET POWER.

(7) RETURN TO F-M SIGNAL.—Turn SIGNAL WIDTH carefully counter-clockwise to MIN, taking care to use same mode.

(8) DETERMINE MINIMUM DISCERNIBLE SIGNAL. (See figure 4-6.)—Turn DBM attenuator until signal just disappears in noise. When signal becomes as small as in part A of figure 4-6, turn the DBM knob in one db steps and move signal back and forth with PHASE knob for identification of signal. When the signal is last visible, read DBM dial.

(9) COMPUTE RECEIVER PERFORMANCE FIGURE:

$$P_{m(dbm)} = (-M_{(dbm)} - A_{(db)} - C_{(db)})$$

where:

$P_{m(dbm)}$ = Receiver performance figure in decibels below one milliwatt (−dbm). (Minimum discernible signal power converted to dbm.)

$M_{(dbm)}$ = Peak power output of the test set in dbm (DBM dial reading).

$A_{(db)}$ = Total attenuation of cable and external attenuators (if any) between test set and directional coupler (or horn) in decibels.

$C_{(dbm)}$ = Coupling of directional coupler in decibels (∂r space loss between radar antenna and horn).

Example: See figure 4-10.

(10) COMPARE WITH RATED P_m.—Compare the measured value of Receiver Performance Figure, P_m, with the rated value. If the rated value is not given in dbm, convert to dbm by use of figure 4-8.

g. COMPUTING PERFORMANCE DATA.

(1) COMPUTING TRANSMITTER PERFORMANCE FIGURE.

(a) MEASURE TRANSMITTER AVERAGE POWER.—Follow procedure of paragrph *4.b.*

(b) CONVERT TO TRANSMITTER PERFORMANCE FIGURE.—Compute as follows:

$$P_{pk(dbm)} = (P_{av(dbm)} + N_{(db)})$$

where:

$P_{pk(dbm)}$ = Transmitter performance figure in decibels above one milliwatt (+dbm) (transmitter peak power converted to dbm).

$P_{av(dbm)}$ = Transmitter average power in decibels above one milliwatt (+dbm).

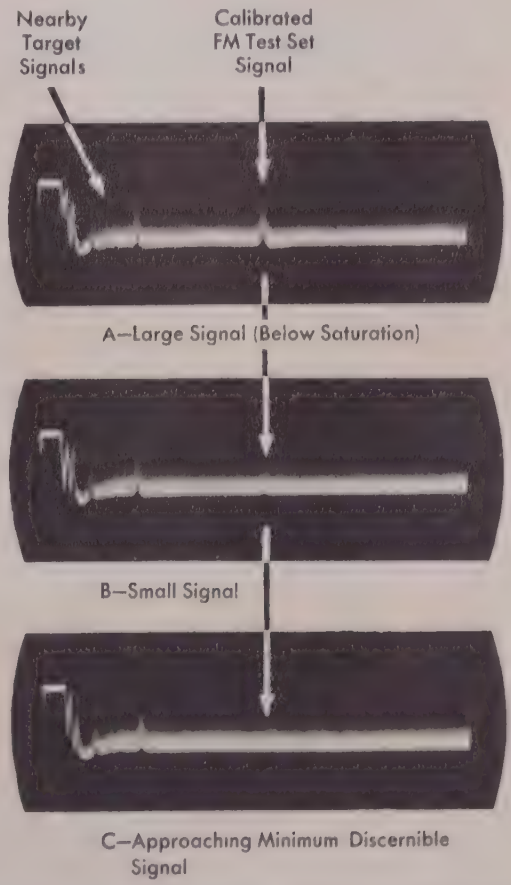


Figure 4—6. Measuring Minimum Discernible Signal Power.

$N_{(db)}$ = Number of decibels to be added to average power in dbm to convert to peak power in dbm (db due to duty cycle), (from figure 4-7).

Example:

$P_{av(dbm)} = 41.5$ dbm.
pulse length = 1 microsecond.
pulse repetition rate = 650/sec.
from figure 2-7, $N_{(db)} = 31.5$ db.
$P_{pk(dbm)} = 41.5$ dbm $+31.5$ db $= +73$ dbm.

(2) COMPUTING RATED TRANSMITTER AVERAGE POWER IN DBM.—If known in watts or kilowatts, convert to dbm by use of figure 4-8. If the rated peak power is known, proceed as follows:

(a) CONVERT RATED P_{pk} TO DBM.—Convert rated transmitter peak power from watts or kilowatts to dbm by use of figure 4-8. This figure is the rated transmitter performance figure, $P_{pk(dbm)}$.

(b) CONVERT RATED TRANSMITTER PERFORMANCE FIGURE TO RATED AVERAGE POWER.—Compute as follows:

$$P_{av(dbm)} = (P_{pk(dbm)} - N_{(db)}).$$

Example:

Rated $P_{pk} = 40$ kilowatts.
from figure 4-8, $P_{pk(dbm)} = +76$ dbm.
for pulse length of 1 microsecond, pulse repetition rate of 650/sec, $N = 31.5$ db from figure 2-7.
Rated $P_{av(dbm)} = +76 - 31.5 = +44.5$ dbm.

(3) COMPUTING OVERALL PERFORMANCE.

(a) DETERMINING RADAR PERFORMANCE FIGURE, S.—The radar performance figure, S, is a measure of the ability of a radar to detect small or distant targets. The effect of external factors such as atmospheric conditions, geometry of target, ground and water reflection is not included in this figure.

1. Compute the radar performance figure from $P_{pk(dbm)}$ obtained in paragraph IV.*4.g.*(1) and P..... obtained in paragraph IV.*4.f.* as follows:

$$S_{(db)} = P_{pk(dbm)} - P_{m(dbm)}.$$

Example:

$P_{pk(dbm)} = +73$ dbm.
$P_{m(dbm)} = -93$ dbm.
$S_{(db)} = +73$ dbm $-(93$ dbm$) = 166$ db.

Note

When considering the ability of a radar to trigger a beacon and receiver, a beacon signal uses the transmitter performance figure $P_{pk(dbm)}$ and the receiver performance figure P.... separately, instead of combining them into the radar performance figure S.

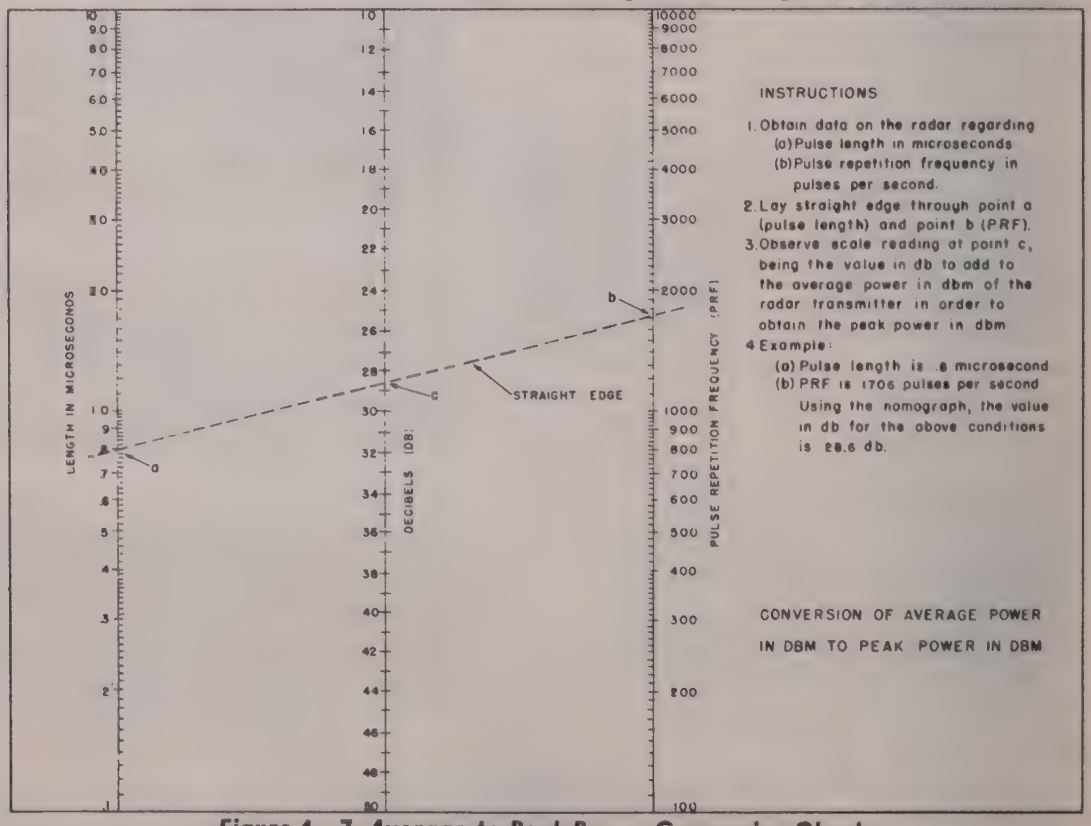

LENGTH IN MICROSECONDS
DECIBELS (DB)
PULSE REPETITION FREQUENCY (PRF)
a
b
c
STRAIGHT EDGE
INSTRUCTIONS
1. Obtain data on the radar regarding
(a) Pulse length in microseconds
(b) Pulse repetition frequency in pulses per second.
2. Lay straight edge through point a (pulse length) and point b (PRF).
3. Observe scale reading at point c, being the value in db to add to the average power in dbm of the radar transmitter in order to obtain the peak power in dbm
4 Example:
(a) Pulse length is .8 microsecond
(b) PRF is 1706 pulses per second
Using the nomograph, the value in db for the above conditions is 28.6 db.
CONVERSION OF AVERAGE POWER IN DBM TO PEAK POWER IN DBM

Figure 4—7. Average-to-Peak Power Conversion Chart.

2. Compare the radar performance figure $S_{(db)}$ with the expected performance figure. The expected figure can be obtained from the expected values of $P_{pk(dbm)}$ and $P_{m(dbm)}$ or the value obtained when the radar is known to be operating satisfactorily.

Example: If the expected radar performance figure $S_{(db)} = 171$ db and the measured radar performance figure $S_{(db)} = 166$ db, the radar performance is down 5 db.

3. The effect on range can be obtained by reference to the following table:

Note

Where $P_{pk(dbm)}$ or $P_{av(dbm)}$ when measured on BEACON is down 2 db and $P_{m(dbm)}$ is down 1.5 db, the range at which the radar could trigger a beacon is down to 79% of normal range and the range at which the radar could receive a beacon signal is down 84% of normal range.

(b) COMPUTING CHANGE IN OVERALL PERFORMANCE.—For routine measurements, time can be saved by adding the differences from rated transmitter average power obtained in paragraph *4.b.*(6) and rated receiver performance figure obtained in paragraph *4.f.(10)* to get change in radar performance figure as is done in figure 4-10, Sample Radar Performance Data Sheet.

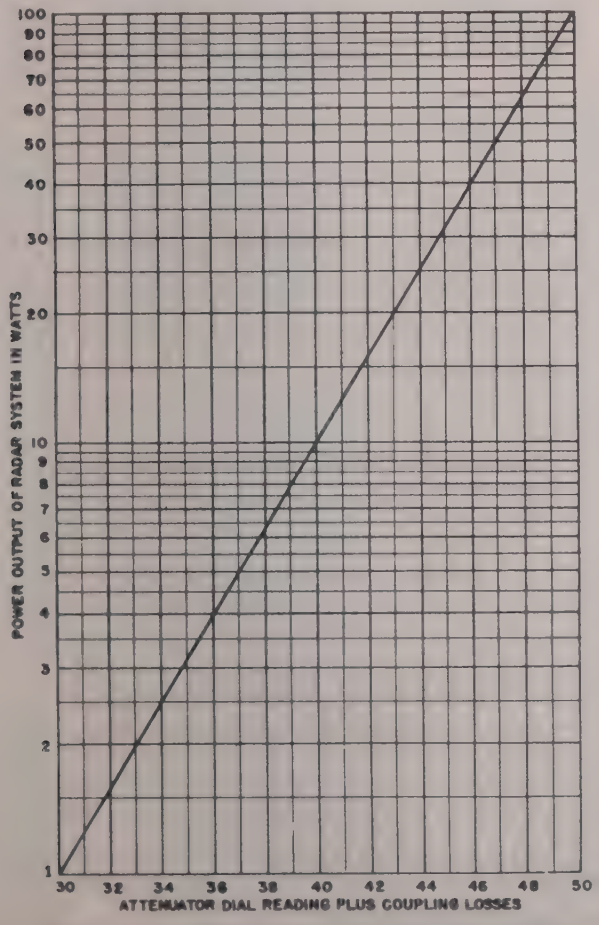


Figure 4—8. DBM-to-Power Conversion Chart.

b. MEASURING TR RECOVERY TIME.—There is an alternate method for measuring TR Recovery Time (or C-W). See paragraph *7.11.b.*

(1) OBTAIN F-M SIGNAL.—Perform the following operations, if not already performed:

Operation	*Paragraph*
Prepare Radar, Test Set and Oscilloscope	*4.d.*(1)
Adjust Radar Receiver	*4.d.*(2)
Tune Test Set to Receiver	*4.d.*(3)
Tune Receiver (if no test signals are obtained)	*4.d.*(4)

(2) ADJUST SIGNAL HEIGHT.—Leave AFC on if operative. Adjust gain for small grass. Adjust DBM knob until signal height is about half way between noise and saturation.

(3) PHASE SIGNAL TOWARD TRANSMITTER PULSE.—Turn PHASE knob counter-clockwise toward MIN until signal height starts to decrease. Measure range from beginning of transmitter pulse to signal.

i. DETECTING TRANSMITTER PULLING AND CHECKING AFC TRACKING.

(1) OBTAIN FM SIGNAL.—Perform the following operations, if not already performed:

Operation	*Paragraph*
Prepare Radar, Test Set, and Oscilloscope	*4.d.*(1)
Adjust Radar Receiver	*4.d.*(2)
Tune Test Set to Receiver	*4.d.*(3)
Tune Receiver (if no test signals are obtained)	*4.d.*(4)

(2) OBTAIN BANDPASS F-M SIGNAL.—Turn PHASE knob clockwise to put signal near center of screen. Broaden signal by turning SIGNAL WIDTH knob part way clockwise. Set FREQUENCY meter for pip on top of curve (f_t).

(3) CHECK FOR PULLING AND PROPER AFC TRACKING.—Start radar antenna spinner. If the F-M signal moves, there is probably pulling (see figure 4-9(4)). If it remains on the screen, the AFC is tracking all right.

j. CHECKING BEACON RESPONSE OF RADAR.

(1) PRELIMINARY.—Switch radar to BEACON, measure crystal current, rectifier current, and modulator current.

(2) MEASURE TRANSMITTER POWER. — Follow paragraph *4.b.* (Most radars have different pulse length and repetition rate on Beacon.)

(3) MEASURE TRANSMITTER FREQUENCY.— Follow paragraph *4.c.*

(4) MEASURE RECEIVER FREQUENCY FOR BEACON RECEPTION. — Follow paragraph *4.d.* substituting 9310 mc for transmitter frequency. First tune beacon receiver by procedure of paragraph *4.k.* if there is no beacon AFC or tuning cavity.

(5) MEASURE RECEIVER PERFORMANCE

FIGURE FOR BEACON RECEPTION.—Follow paragraph *4.f.*

k. TUNING RADAR RECEIVERS. (For use when results are not satisfactory in paragraph *4.d.* or when there is no AFC.)

(1) PREPARE RADAR, TEST SET, AND OSCILLOSCOPE.—Perform the following operations, if not already performed:

Operation	*Paragraph*
Prepare Radar	*4.a.*(1)
Prepare TS-147C/UP	*4.a.*(2)
Prepare Oscilloscope	*4.a.*(3)

(2) ADJUST RADAR RECEIVER.—Set radar on manual tuning. Set gain high enough to show small grass on A or J-scope.

(3) SET TS-147C/UP FOR RCVR TEST. — Set TEST knob to RCVR; DBM knob to about +50 dbm; POWER SET, knob near maximum (clockwise); PHASE knob near mid position.

(4) TUNING RECEIVER TO TRANSMITTER (OR BEACON) FREQUENCY.—(To be used, if necessary, after paragraph *4.d.*(4).)

(a) SET TS-147C/UP ON CW.—Turn SIGNAL WIDTH knob clockwise to CW. Maximize meter reading with PHASE control. Leave TEST on RCVR, set DBM to about −50 dbm.

(b) SET TS-147C/UP TO TRANSMITTER (or BEACON) FREQUENCY. — Adjust SIGNAL FREQ.

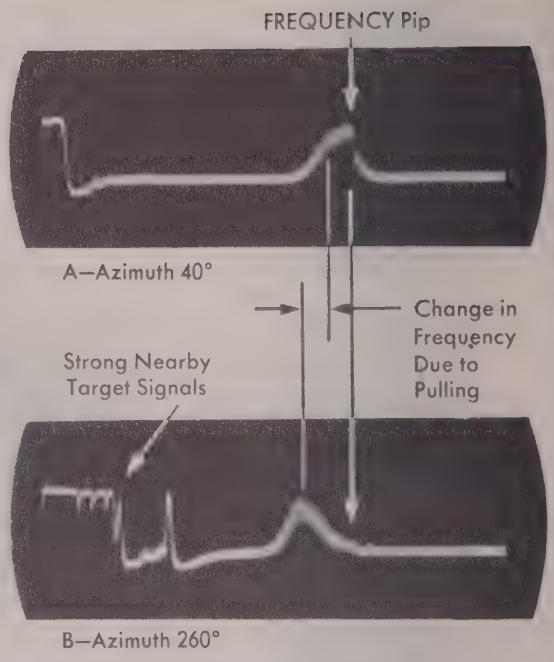


Figure 4—10. Checking Transmitter Pulling and AFC Tracking.

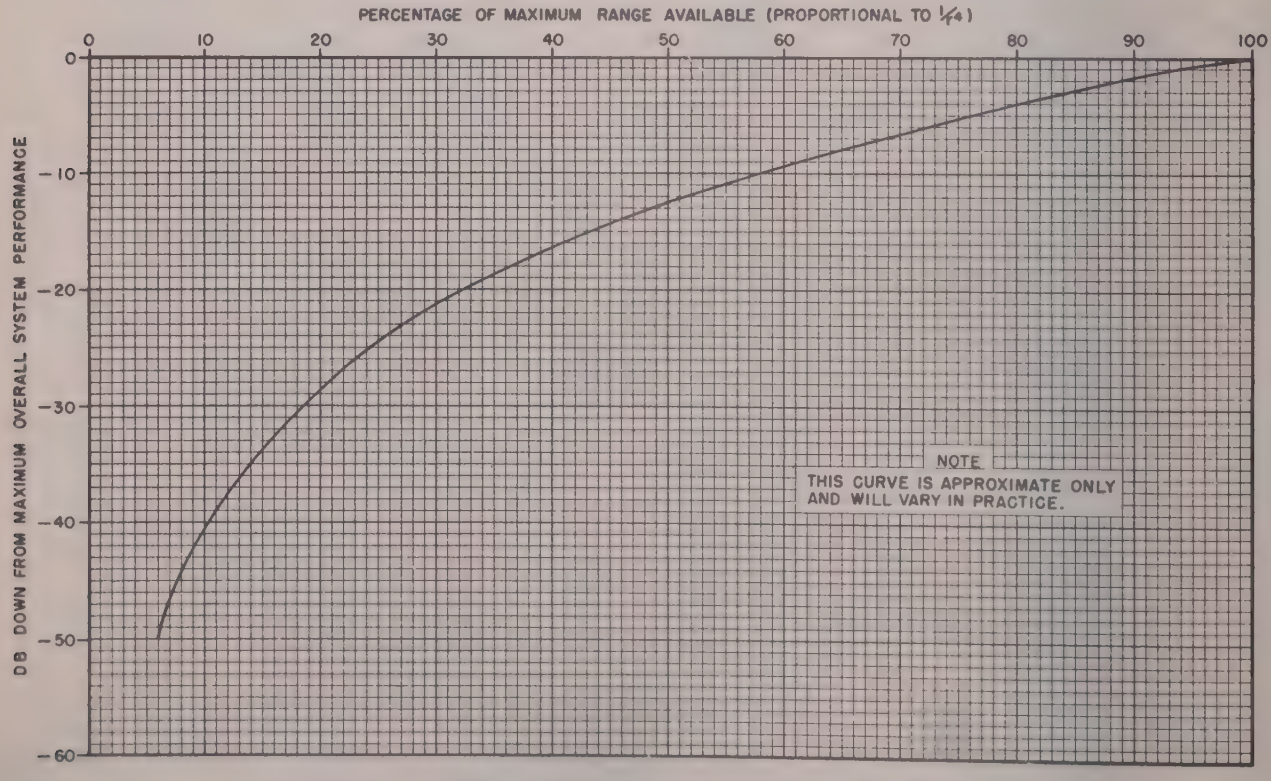
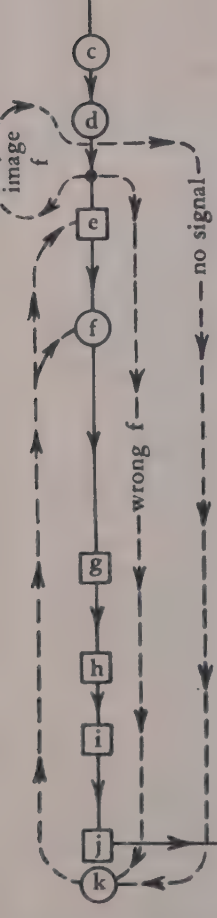


Figure 4—9. Radar Performance Versus Radar Range.

Radar AN/APS-15A Serial No. 1725 TS-147C/UP No. 2 Observer FBI Date 2/15/49



SEARCH

Preliminary Procedure

Radar Modulator Current ..... 7.5 ma
Radar Rectifier Current ..... 9.0 ma
Radar Crystal Current ..... 0.6 ma

Transmitter Average Power

DBM Dial Reading ..... +17.5 dbm
Cable Attenuation ..... A 4 db
Coupling ..... C 20 db
Total ..... P_{av} +41.5 dbm
Rated ..... +44.5 dbm
Difference ..... -3 db

Transmitter Frequency

Reading 936.5, Frequency .... f_t 9365 Mc

Receiver Frequency

Reading 9366
Frequency ..... f_r 9366 Mc

Receiver Bandwidth

Readings (1) 936.5 (2) 936.7
Bandwidth, f_1 9365 f_2 9367 B 2 Mc

Receiver Performance Figure (Sensitivity)

DBM Dial Reading ..... -69 dbm
Cable Attenuation ..... —A -4 db
Coupling ..... —C -20 db
Total ..... P -93 dbm
Rated ..... —(-95) dbm
Difference ..... -2 db

Overall Performance

Differences ⓑ -3 db ... ⓕ +2 db
Overall Difference ..... (b-f) -5 db

TR Recovery

Range ..... 0.2 miles

Transmitter Pulling; AFC Tracking

Transmitter Pulling: No ☑ Yes ☐
AFC Tracking .... Good ☑ Poor ☐

Beacon Response of Radar

Receiver Tuning

BEACON

j(1) Preliminary
7.0 ma
8.6 ma
0.55 ma

j(2) Trans. P_{av}
+18.5 dbm
A 4 db
C 20 db
P_{av} +42 dbm
+44.5 dbm
-2 db

j(3) f_t on Beacon
f_t 9365 Mc

j(4) f_r for Beacon
931.0
f_r 9310 Mc

j(5) P_m for Beacon
-59.5 dbm
—A -4 db
—C -20 db
P_m -83.5 dbm
—(-85) dbm
-1.5 db

Maintenance Notes:

Figure 4—11. Sample Radar Performance Data Sheet.

knob to transmitter (or beacon) frequency, resetting PHASE knob when meter drops 10%, checking frequency by dipping meter with FREQUENCY control.

(c) SET TS-147C/UP ON FM.—Turn SIGNAL WIDTH knob to MIN. Set TEST knob to (dot).

(d) DETUNE RECEIVER LOCAL OSCILLATOR.—Set radar on manual tuning. Set local oscillator at extreme end of tuning range, but on correct side of transmitter (or beacon) frequency. Adjust local oscillator for crystal current.

(e) TUNE RECEIVER TO TS-147C/UP.—Tune receiver local oscillator mechanical tuning slowly toward center of its range, resetting reflector voltage when crystal current drops, watching for FM signal on oscilloscope. Tune mechanical tuner of receiver for maximum FM signal, and maximum crystal current. Set TEST knob to RCVR. Then adjust setting of DBM attenuator, if necessary, to prevent saturation.

(f) OBTAIN F-M BANDPASS CURVE.—Carefully broaden the SIGNAL WIDTH while holding the signal in view with the PHASE control until bandpass curve is obtained. Adjust local oscillator to get FREQUENCY pip on top of curve.

(5) ADJUST RADAR R-F COMPONENTS. — Tune TR and ATR for maximum TS-147C/UP signal. Adjust DBM attenuator to avoid saturated signal while tuning. Adjust crystal current for proper value. Readjust L-O, TR, and ATR to compensate for interaction.

(6) COMPARE AFC AND MANUAL.—Switch to AFC. If pattern moves more than a few megacycles frequency, adjust AFC discriminator secondary. If pattern disappears on AFC, either the AFC is inoperative or the manual tuning is on the wrong side of the transmitter frequency.

5. SUMMARY OF RADAR PERFORMANCE MEASUREMENT.

Note

These abridged instructions are for use in sequence. Sub-paragraphs which may be skipped without upsetting the following paragraphs are enclosed in square □ blocks on Blank Radar Performance Data Sheet. To perform individual tests out of sequence, refer to paragraph *4*.

a. PRELIMINARY PROCEDURE.

(1) RADAR.—Turn radar on, observe modulator current, rectifier current, and crystal current. Leave radar spinner stationary.

(2) TS-147C/UP.—Turn TEST to TRAN; DBM all the way counter-clockwise. Connect and turn 115V AC to ON. Connect cable CG-92A/U cable from RF to radar directional coupler (or test horn).

(3) TS-34/AP (not used if Radar has A or J-scope). —Turn POWER ON; set to NORMAL; SWEEP SELECTOR to START-STOP; SWEEP SPEED to MED; INPUT IMPEDANCE to HIGH; ATTENUATION to 20 db. Switch to EXT SYNC and connect radar trigger to EXT SYNC (or use INT SYNC). Connect radar video signal to SIGNAL INPUT (TS-34/AP). Adjust INPUT IMPEDANCE and ATTENUATION for convenient signal height. Adjust SYNC VOLTAGE for steady signals (check SYNC POLARITY).

b. TRANSMITTER AVERAGE POWER (P_{av}).

(1) BALANCE METER.—With TEST to TRAN and DBM full counter-clockwise, adjust METER BALANCE until meter is at BALANCE.

(2) SET POWER.—Turn DBM dial clockwise, reducing attenuation until meter pointer is below SET POWER. Detune FREQUENCY meter. Set meter to SET POWER by turning DBM dial counter-clockwise to take up backlash. Read DBM dial and record.

(3) COMPUTE TRANSMITTER AVERAGE POWER (P_{av}).—Compute as follows:

P_{av} = +DBM reading +A +C. (See Blank Radar Performance Data Sheet.)

(4) COMPARE WITH RATED P_{av}. — Compute difference from rated P_{av}.

c. TRANSMITTER FREQUENCY (f_t).—Tune FREQUENCY knob for dip in meter. Carefully set to maximum dip turning FREQUENCY knob counter-clockwise to avoid backlash. Record reading and multiply by ten.

d. RECEIVER FREQUENCY.—Leave radar AFC on (if operative) and set gain sufficient to show small grass.

(1) TUNE TEST SET TO RECEIVER.

(a) SET TS-147C/UP FOR TUNING.—Set TEST to (dot) position between TRAN and RCVR; DBM to −15 dbm; POWER SET near maximum (clockwise); phase near mid position.

(b) OBTAIN FM SIGNALS. — Set SIGNAL WIDTH to MIN. Adjust SIGNAL FREQ. for maximum signal; set TEST to RCVR and adjust DBM knob to prevent saturation. Proceed to step (3) unless no signal is obtained over the SIGNAL FREQ range.

(2) TUNE RECEIVER (If no test signals).—Maximize crystal current with local oscillator manual reflector voltage control. Adjust coupling, if necessary, to obtain crystal current. Tune for maximum target signals or echo box signal with local oscillator mechanical tuning. Readjust reflector voltage when necessary to obtain maximum crystal current. Then tune test set to receiver as in step (1). If no target signals can be observed, tune receiver with test set, see paragraph *5.k.* (or use echo box).

(3) MEASURE f_r.

(a) OBTAIN BANDPASS CURVE.—Turn SIGNAL WIDTH to obtain bandpass curve. Adjust PHASE control to hold pattern on oscilloscope screen.

(b) OBSERVE FREQUENCY. — Adjust FREQUENCY control so that pip is on top of bandpass curve. Record reading and multiply by ten. If f_r differs from f_t (or beacon) by twice the radar intermediate frequency, repeat paragraph *5.d.*(1) and select the alternative signal (clockwise rotation of SIGNAL FREQ decreases frequency). If the frequency differs from transmitter (or beacon) frequency, by other than twice intermediate frequency, AFC trouble is indicated. If AFC is inoperative, see paragraph *5.k.* for manual tuning.

e. MEASURE BANDWIDTH (Optional).

(1) OBTAIN HALF POWER HEIGHT.—Increase the setting of DBM attenuator by 3.0 db; detune FREQUENCY meter; and mark height. Restore DBM to original setting.

(2) MEASURE FREQUENCY DIFFERENCE. — Move the FREQUENCY meter pip across the curve, observing the readings at the two points where it goes through the half power line determined in *(a)*.

Bandwidth, $B = f_1 - f_2$.

f. RECEIVER PERFORMANCE FIGURE P_m (SENSITIVITY).—Leave radar AFC on (if operative) and set gain to show grass one-half of main bang amplitude.

(1) SET SIGNAL POWER ON C-W. — Broaden bandpass curve to maximum by turning SIGNAL WIDTH clockwise to CW, while holding pattern on screen with PHASE control. Detune FREQUENCY meter. Adjust POWER SET knob so that meter reads SET POWER.

(2) RETURN TO F-M SIGNAL.—Turn SIGNAL WIDTH to MIN, being careful to keep the correct signal for use.

(3) DETERMINE MINIMUM DISCERNIBLE SIGNAL.—Turn DBM attenuator until signal just disappears in noise. Move signal back and forth with PHASE knob for identification. Record DBM dial reading. Compute receiver performance figure:

$P_m = -$DBM reading $-A - C$. (See Radar Performance Data Sheet.)

(4) COMPARE WITH RATED P_m.—Compute difference from rated P_m.

g. OVERALL PERFORMANCE.—Combine the difference from parts *b* and *e* of the data sheet to obtain the difference in overall performance figure from rated performance figure.

h. TR RECOVERY TIME.—Leave AFC on, if operative. Adjust gain for small grass.

(1) RESTORE F-M SIGNAL (which disappeared in paragraph 5.*f.*(3)).—Turn DBM knob clockwise until signal height is about half way between noise and saturation.

(2) PHASE SIGNAL TOWARD TRANSMITTER PULSE.—Turn PHASE knob counter-clockwise toward MIN until signal height starts to decrease. Measure range from beginning of transmitter pulse to signal.

i. DETECTING TRANSMITTER PULLING AND CHECKING AFC TRACKING.

(1) OBTAIN BANDPASS F-M SIGNAL.—Turn PHASE knob clockwise to put signal near center of screen. Broaden signal by turning SIGNAL WIDTH part way clockwise. Set FREQUENCY meter for pip on top of curve (f_t).

(2) CHECK FOR PULLING AND PROPER AFC TRACKING.—Start radar antenna spinner. If the F-M signal moves, there is probably pulling. If it remains in synchronism with the spinner, the AFC is tracking all right.

j. BEACON RESPONSE OF RADAR.

(1) PRELIMINARY.—Switch radar to BEACON, measure crystal current and modulator current.

(2) MEASURE TRANSMITTER POWER. — Follow paragraph 5.*b.* (Most radars have different pulse length and repetition rate on Beacon.)

(3) MEASURE TRANSMITTER FREQUENCY.—Follow paragraph 5.*c.*

(4) MEASURE RECEIVER FREQUENCY FOR BEACON RECEPTION. — Follow paragraph 5.*d.*, substituting the beacon frequency for transmitter frequency. First tune beacon receiver by procedure of paragraph 5.*k.*, if there is no beacon AFC or tuning cavity.

(5) MEASURE RECEIVER PERFORMANCE FIGURE FOR BEACON RECEPTION.—Follow paragraph 5.*c.*

k. RECEIVER TUNING. *(For use when results are not satisfactory in paragraph 5.d. or there is no AFC.)*—Switch radar from AFC to manual tuning.

(1) TUNE RECEIVER TO TRANSMITTER (OR BEACON) FREQUENCY.—*(To be used, if necessary, after paragraph 5.d.*(2).).

(a) SET TS-147C/UP ON CW.—Turn SIGNAL WIDTH clockwise to CW. Maximize meter reading with PHASE control. Leave TEST on RCVR, set DBM to about −50 dbm.

(b) SET TS-147C/UP TO TRANSMITTER (or BEACON) FREQUENCY.—Adjust SIGNAL FREQ to transmitter (or beacon) frequency resetting PHASE when meter drops 10%, checking frequency by dipping meter with FREQUENCY control.

(c) SET TS-147C/UP ON FM.—Turn SIGNAL WIDTH to MIN. Set TEST to (dot).

(d) DETUNE RECEIVER LOCAL OSCILLATOR.—Set radar on manual tuning. Set local oscillator at extreme end of tuning range, but on correct side of transmitter (or beacon) frequency. Adjust local oscillator for crystal current.

(e) TUNE RECEIVER TO TS-147C/UP.—Turn radar local oscillator mechanical tuning slowly toward center of its range, resetting the reflector voltage when crystal current drops, watching for FM signal on oscilloscope. Tune mechanical tuner of receiver for maximum FM signal and adjust reflector voltage for maximum crystal current. Set TEST to RCVR. Then adjust setting of DBM attenuator, if necessary, to prevent saturation.

(f) OBTAIN F-M BANDPASS CURVE.—Carefully broaden the SIGNAL WIDTH while holding the signal in view with the PHASE control until bandpass curve is obtained. Adjust local oscillator to get FREQUENCY pip on top of curve.

(2) ADJUST RADAR R-F COMPONENTS. — Tune TR and ATR for maximum TS-147C/UP signal. Adjust DBM attenuator to avoid saturated signal while tuning. Adjust crystal current for proper value. Readjust L-O, TR, and ATR to compensate for interaction.

(3) COMPARE AFC AND MANUAL.—Switch to AFC. If pattern moves more than half the bandwidth, the AFC needs adjustment. If pattern disappears on AFC, either the AFC is inoperative or the manual tuning is on the wrong side of the transmitter frequency.

(4) CONTINUE WITH PERFORMANCE CHECK.—Return to paragraph 5.*d.*(2).

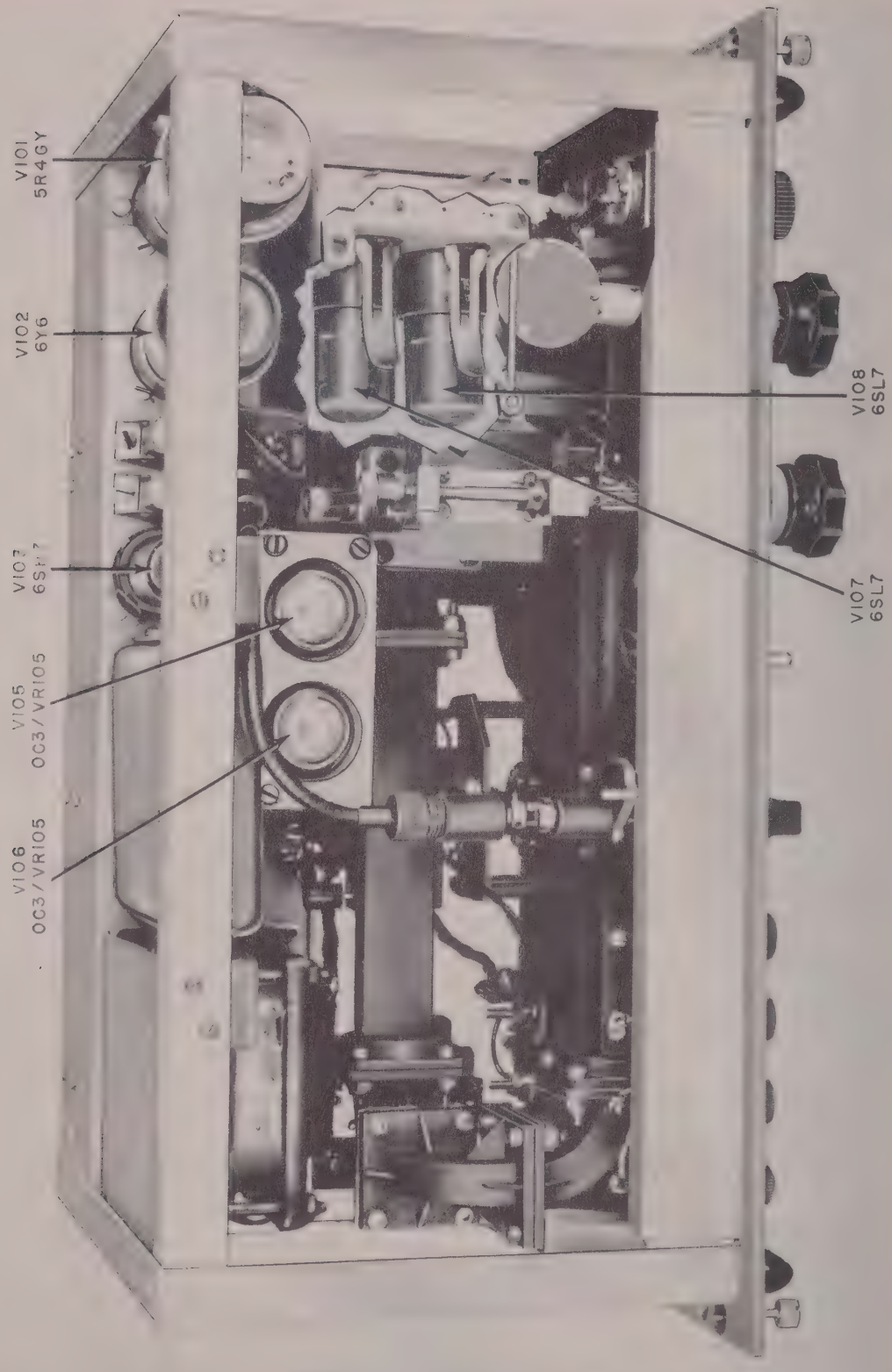


Figure 5—1. Tube Locations.

SECTION 5

OPERATOR'S MAINTENANCE

WARNING

Operation of this equipment involves the use of high voltages which are dangerous to life. Operating personnel must at all times observe safety regulations. Do not change the tubes or make adjustment with the high voltage supply on. Do not depend on switches for protection. Always remove the power input plug. Under certain conditions, even with the power removed dangerous potentials may exist in circuits because of charges retained by capacitors. Discharge and ground circuits by means of a grounding rod or a similar device by touching them. Do not ground any high voltage points when the equipment is operating. Grounding them will blow fuses, burn out circuit elements and may cause personal injury.

1. INTRODUCTION.

This section is limited to a discussion of operator's duties in relation to maintenance of Test Set TS-147C/UP. The operator is assumed to have little or no technical knowledge insofar as the theory of the operation of the equipment is concerned. Therefore, he will not be required to make any of the fine adjustments or intricate changes which demand the attention of experienced maintenance personnel. However, the operator should be capable of making the adjustments described in detail in Section 4. In addition, the operator is required to replace fuses and tubes when one or more of them has failed. It is expected that the operator will usually make changes or adjustments during the course of battle. This fact will further limit his maintenance activity to those adjustments relatively short in time.

2. LAMPS.

Test Set TS-147C/UP uses Lamps I-101 and I-102. These lamps operate on a three volt filament supply. If either or both lamps fail during the course of operation replace them immediately with new lamps from the operating spares in the transit case. Should the replacements fail immediately or within a short time after installation it can be assumed that the cause of failure is not the lamp but a more serious failure in the test set circuits themselves. In such an event call upon an experienced maintenance man for assistance. In emergency, the equipment can be operated without the use of the lamps.

3. TUBES.

In the event that the equipment should fail during operation a quick check may reveal the defective tube which can be immediately replaced. An experienced operator can readily detect the defective tube by checking to see if it is lit or in the case of tubes with metal envelope by touching them to see if they are warm. If the replacement fails immediately or within a short time after installation it can be assumed that the cause of failures is hidden in the circuits themselves. In this event, an experienced maintenance man should be called in to repair the equipment.

WARNING

Operating personnel must not conduct any checks or tests inside the equipment which requires the attention of highly trained maintenance personnel. Figure 5-1 shows the location of all tubes in the equipment. Tube type numbers are also indicated in order to facilitate replacements.

4. FUSES.

Test Set TS-147C/UP uses two fuses F-101 and F-102 to protect the circuits and components from excessive surges. These fuses are located in the 115V, 50 to 1600 cycle single phase power supply line. A burnt out fuse can be easily detected by observation, or if necessary, by making a continuity check across the fuse terminals with an ohmmeter. The burnt out fuse should be replaced with one from the operating spares compartment of the transit case. If the replacement blows immediately or within a short time after installation the cause of failure is in the test set circuits or the power supply to the equipment.

5. OPERATOR CHECKS.

At the beginning of each watch the operator who comes on duty should make the following checks before operating the equipment.

a. See that all plugs and jacks are properly connected.

b. See that all tubes are lit or, in case of tubes with metal envelopes, are warm to the touch.

c. See that the fuses are not burnt out. Remove each fuse and submit it to a continuity check with an ohmmeter, if tubes and dial lamps do not light.

SECTION 6

PREVENTIVE MAINTENANCE

1. ROUTINE MAINTENANCE CHECK CHARTS.

(See Table 6-1.)

Periodic mechanical and electrical checks should be made to assure continuity of service at peak performance of Test Set TS-147C/UP. Table 6-1 sets forth the procedure to be followed:

Note

The attention of maintenance personnel is invited to the requirements of Chapter 67 of BuShips Manual, of the latest issue.

2. LUBRICATION.

Lubrication is not required on any portion of Test Set TS-147C/UP.

TABLE 6-1. ROUTINE MAINTENANCE CHECK CHARTS

WEEKLY		
WHAT TO CHECK	HOW TO CHECK	PRECAUTIONS
1. Connections	Inspect external connections for signs of corrosion. Examine for loose connections.	
2. Seating	Inspect the seating of tubes and crystals, connectors and resistors.	
3. Controls	Inspect all controls for binding, scraping, excessive looseness, misalinement, and worn action.	
4. Operation	Check for normal operation.	

MONTHLY		
WHAT TO CHECK	HOW TO CHECK	PRECAUTIONS
1. Meters	Inspect meters for damaged glass and cases.	
2. Operation	Perform initial adjustment test as outlined in Section 3, paragraph 6.	

QUARTERLY

WHAT TO CHECK	HOW TO CHECK	PRECAUTIONS
		Disconnect all power before performing the following operations. Upon completion, reconnect power and check for satisfactory operation.
1. Wiring	Inspect all wiring for signs of wear, broken or split insulation, discoloration due to overheating.	
2. Terminal boards	Inspect all terminal boards for cracks, dirt, loose connections, and terminals for corrosion.	
3. Resistors and capacitors	Inspect resistors and capacitors for blistering and discoloration due to overheating.	
4. Power transformer	Inspect power transformer T-101 for excessive heating.	
5. Fuses	Inspect fuses F-101 and F-102 and fuse holders for corrosion, cracks, and lack of tension sufficient to secure good contact. Refill spare fuse holders if required.	
6. Switches	Inspect switch S-101 for dirty or corroded contacts, cracked and broken insulation and loose connections.	
7. Mechanical fittings	Inspect all mountings, machine screws, and nuts for looseness. Inspect moving parts for binding and wear.	
8. Knobs	Inspect knobs for cracks and breaks. Tighten loose set screws.	
9. Power cable	Inspect power cable and connectors for worn or frayed insulation, corroded and loose connections, and loosened fittings and screws.	
10. RF cables	Inspect RF cables for worn or frayed insulation, corroded and loose connections, and loosened fittings and screws.	

FAILURE REPORTS

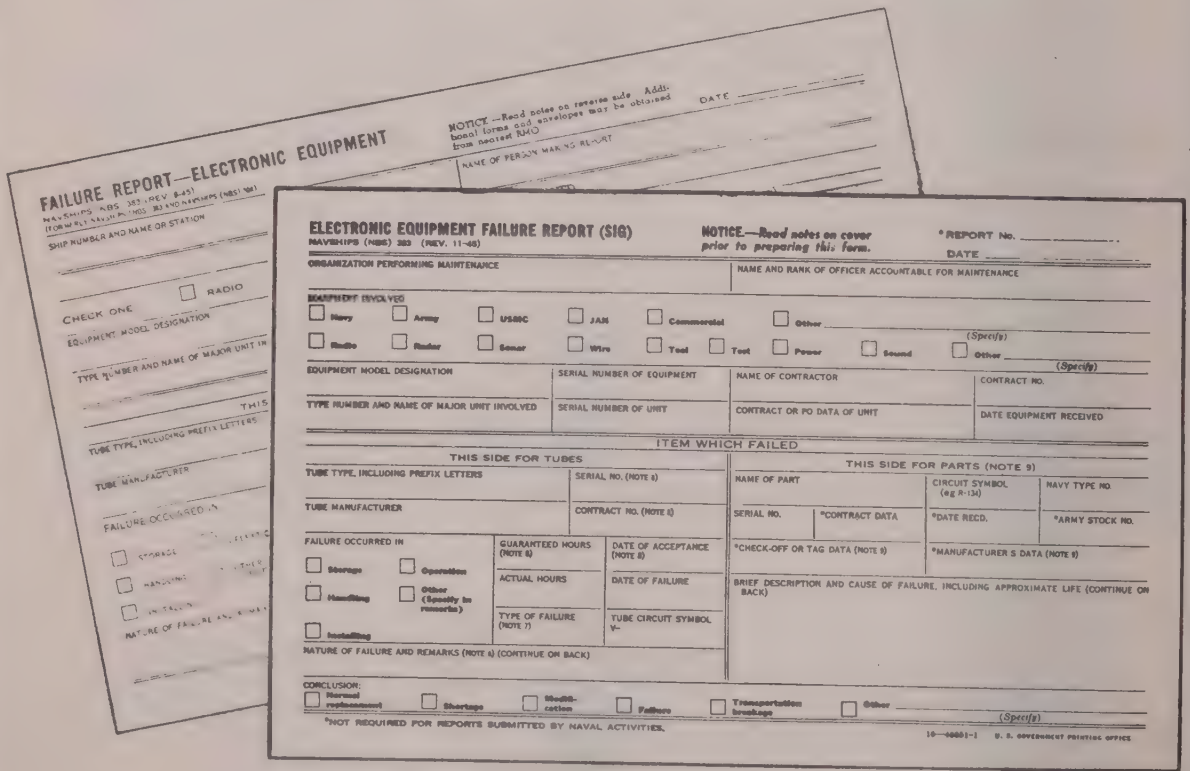
A FAILURE REPORT must be filled out for the failure of any part of the equipment whether caused by defective or worn parts, improper operation, or external influences. It should be made on Failure Report, form NBS-383, which has been designed to simplify this requirement. The card must be filled out and forwarded to BUSHIPS in the franked envelope which is provided. Full instructions are to be found on each card.

Use great care in filling the card out to make certain it carries adequate information. For example, under "Circuit Symbol" use the proper circuit identification taken from the schematic drawings, such as T-803, in the case of a transformer, or R-207, for a resistor. Do not substitute brevity for clarity. Use the back of the card to completely describe the cause of failure and attach an extra piece of paper if necessary.

The purpose of this report is to inform BUSHIPS of the cause and rate of failures. The information is used by the Bureau in the design of future equipment and in the maintenance of adequate supplies to keep the present equipment going. The cards you send in, together with those from hundreds of other ships, furnish a store of information permitting the Bureau to keep in touch with the performance of the equipment of your ship and all other ships of the Navy.

This report is not a requisition. You must request the replacement of parts through your Officer-in-Charge in the usual manner.

Make certain you have a supply of Failure Report cards and envelopes on board. They may be obtained from any Electronics Officer.



FAILURE REPORT—ELECTRONIC EQUIPMENT

NOTICE—Read notes on reverse side. Addl. bonaf forms and envelopes may be obtained from nearest RMO

DATE

NAME OF PERSON MAKING REPORT

SHIP NUMBER AND NAME OR STATION

CHECK ONE ☐ RADIO

EQUIPMENT MODEL DESIGNATION

TYPE NUMBER AND NAME OF MAJOR UNIT IN

THIS

TUBE TYPE, INCLUDING PREFIX LETTERS

TUBE MANUFACTURER

FAILURE OCCURRED IN

☐ STORAGE

☐ HANDLING

☐ INSTALLING

NATURE OF FAILURE AND REMARKS

ELECTRONIC EQUIPMENT FAILURE REPORT (SIG)

NAVSHIPS (NBS) 383 (REV. 11-48)

NOTICE—*Read notes on cover prior to preparing this form.*

*REPORT No. _____

DATE _____

ORGANIZATION PERFORMING MAINTENANCE

NAME AND RANK OF OFFICER ACCOUNTABLE FOR MAINTENANCE

EQUIPMENT INVOLVED

☐ Navy ☐ Army ☐ USMC ☐ JAN ☐ Commercial ☐ Other _____

☐ Radio ☐ Radar ☐ Sonar ☐ Wire ☐ Test ☐ Test ☐ Power ☐ Sound ☐ Other _____ (Specify)

EQUIPMENT MODEL DESIGNATION | SERIAL NUMBER OF EQUIPMENT | NAME OF CONTRACTOR | CONTRACT NO.

TYPE NUMBER AND NAME OF MAJOR UNIT INVOLVED | SERIAL NUMBER OF UNIT | CONTRACT OR PO DATA OF UNIT | DATE EQUIPMENT RECEIVED

ITEM WHICH FAILED

THIS SIDE FOR TUBES

TUBE TYPE, INCLUDING PREFIX LETTERS | SERIAL NO. (NOTE 6)

TUBE MANUFACTURER | CONTRACT NO. (NOTE 6)

FAILURE OCCURRED IN ☐ Storage ☐ Operation ☐ Handling ☐ Other (Specify in remarks) ☐ Installing

GUARANTEED HOURS (NOTE 6) | DATE OF ACCEPTANCE (NOTE 6)

ACTUAL HOURS | DATE OF FAILURE

TYPE OF FAILURE (NOTE 7) | TUBE CIRCUIT SYMBOL V-

NATURE OF FAILURE AND REMARKS (NOTE 6) (CONTINUE ON BACK)

THIS SIDE FOR PARTS (NOTE 9)

NAME OF PART | CIRCUIT SYMBOL (eg R-134) | NAVY TYPE NO.

SERIAL NO. | *CONTRACT DATA | *DATE RECD. | *ARMY STOCK NO.

*CHECK-OFF OR TAG DATA (NOTE 9) | *MANUFACTURER S DATA (NOTE 9)

BRIEF DESCRIPTION AND CAUSE OF FAILURE, INCLUDING APPROXIMATE LIFE (CONTINUE ON BACK)

CONCLUSION: ☐ Normal replacement ☐ Shortage ☐ Modification ☐ Failure ☐ Transportation breakage ☐ Other _____ (Specify)

*NOT REQUIRED FOR REPORTS SUBMITTED BY NAVAL ACTIVITIES.

16—40051-1 U. S. GOVERNMENT PRINTING OFFICE

Figure 7—1. Failure Report, Sample Form.

SECTION 7

CORRECTIVE MAINTENANCE

1. INTRODUCTION.

The procedures, illustrations and tables in this section are aimed at assisting maintenance personnel to repair and adjust Test Set TS-147C/UP. If the equipment has failed in operation the source of the trouble must be located, the defect remedied and the equipment restored to operating condition. Procedure for corrective maintenance is therefore presented in the following order:

Localization of trouble (par. 2).
Removal of chassis from case and disassembly (par. 3).
Trouble shooting and repair (par. 4).

Note

Maintenance personnel must fill out a daily report for each part, component, tube or mechanical assembly repaired or replaced. See sample failure report shown in figure 7-1.

2. LOCALIZATION OF TROUBLE.

a. INTRODUCTION.—Trouble shooting problems in Test Set TS-147C/UP must be accomplished by inspecting the entire equipment in an attempt to localize the trouble to the faulty unit. Check the cables and connectors. Determine that the required power is applied to the power supply. The tuning dial pilot lights I-101 and I-102 serve to indicate power application. Check to insure that panel operating controls are properly employed as described in Section 4. Consult the trouble shooting chart figure 7-2 for aid in locating a faulty stage. Because the test set is a calibrated measuring instrument the field maintenance of the test set is necessarily limited to trouble shooting in the electrical circuits and to replacement of complete assemblies in the plumbing. At all times, field maintenance personnel must take care to avoid disturbing the fixed adjustments on any calibrated assembly. If calibration of any part is changed then the only practical field procedure is to replace the entire assembly with a factory calibrated unit.

3. REMOVAL OF CHASSIS ASSEMBLY FROM CASE.

Upon determining that the trouble source is in an unexposed area of Test Set TS-147C/UP the next step is to remove the chassis from its case and trace the trouble to a faulty component.

a. Loosen the five captive screw fasteners which attach the control panel to the cabinets. These fasteners are marked A in figure 7-4.

b. Carefully slide the chassis assembly out of the cabinet. Avoid bumping components against the flange in the top of the cabinet.

4. TROUBLE SHOOTING AND REPAIR.

a. Trouble shooting data.
(1) Schematic diagram Figure 7-13.
(2) Wiring Diagram Figure 7-14, 7-15.
(3) Trouble Shooting Chart Figure 7-2.
(4) Voltage and Resistance Data Figure 7-8, 7-9.
(5) Winding Data, Table 7-3.
(6) Parts Location Figure 7-3, 7-4, 7-5, 7-6, and 7-7.

b. Repair and adjustment data.
(1) Tube change.

Note

All tubes of a given type supplied with the equipment shall be consumed prior to employment of tubes from general stock.

c. With one exception (V-104), all tubes are easily accessible and can be removed and replaced in the ordinary manner. Rectifier tube V-101 and the regulator control tube V-102 are held in place by clamps which buckle around the bases of the tubes.

d. Replacement of test oscillator tube V-104 (see figures 2-7, 7-4, 7-7).

(1) Loosen the two set screws that secure the SIGNAL FREQ knob (figure 7-7).

(2) Unfasten the SIGNAL FREQ knob lock from the shaft bushing.

(3) Unfasten the bushing from the threaded portion of the cover of the tube mount assembly.

(4) Pull out the SIGNAL FREQ knob shaft completely.

(5) Release the securing snap wire and remove the cover of the tube mount assembly after using the fingers to bring the stop nut up the threaded portion of the tube mount cover.

(6) Disconnect the cap of the oscillator tube.

(7) Push the tube clamp away from the tube and carefully pull the oscillator tube from its socket.

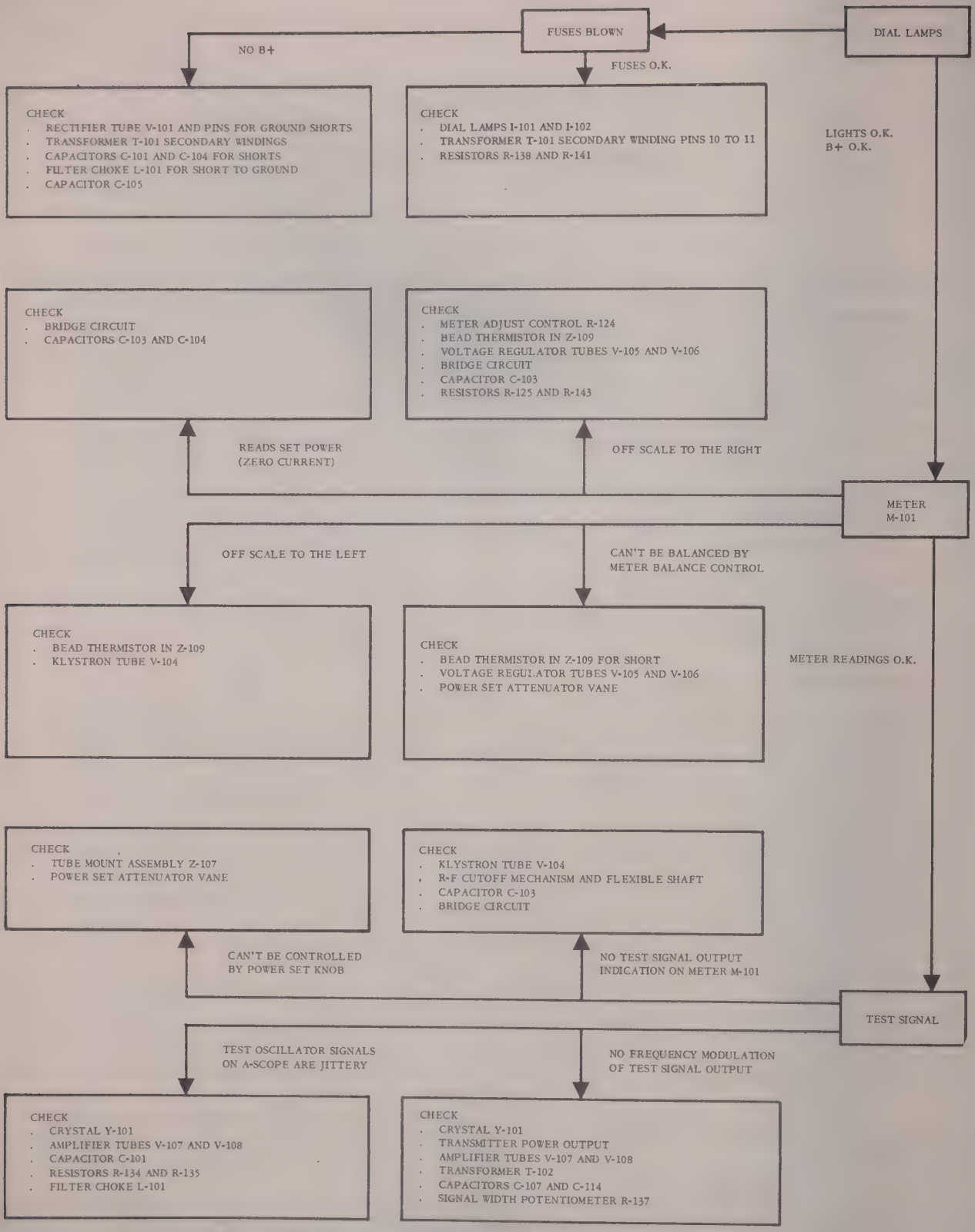


Figure 7—2. Test Set TS-147C/UP, Trouble Shooting Chart.

(8) Insert a new tube into the socket. The output probe of the tube fits into the large pin hole (pin 4) in the socket. See that the tube is pressed all the way down into the socket.

(9) Replace the tube cap connection.

(10) Replace the cover of the tube mount assembly using the fingers to bring the stop nut down the threaded portion of the tube mount cover.

(11) Push the SIGNAL FREQ knob shaft with a twisting motion until the shaft coupling engages the tuning knob on the tube.

(12) Tighten the shaft bushing on the threaded portion of the tube mount cover from the front panel of the chassis.

(13) Replace the SIGNAL FREQ knob lock on the shaft.

(14) Replace the SIGNAL FREQ knob by tightening the two set screws that secure it to the shaft.

e. Removal of Amplifier Unit from Power Supply Chassis.

(1) Remove the four amplifier mounting screws marked "D" in Figure 7-4.

(2) The unit can now be moved away from the chassis for repair. If it is desirable to remove the unit entirely unsolder the five wires which connect to the small square terminal board on the amplifier.

5. PART REPLACEMENT BY OPERATING SPARES SUPPLIED IN TEST SET TS-147C/UP.

a. GENERAL.

Parts of the Test Set TS-147C/UP which can be most easily damaged are supplied in duplicate in the operating spares contained in the test set. The complete set of spares supplied for this test set is listed in the following paragraph. The following replacements can be made by operating personnel:

Note

All spares for overseas shipment are packed in moisture proof bags and do not appear as shown in the illustrations.

b. GASKETS.

Nine gaskets for use in waveguide gasket plans joints are supplied in the operating spares. These gaskets are to

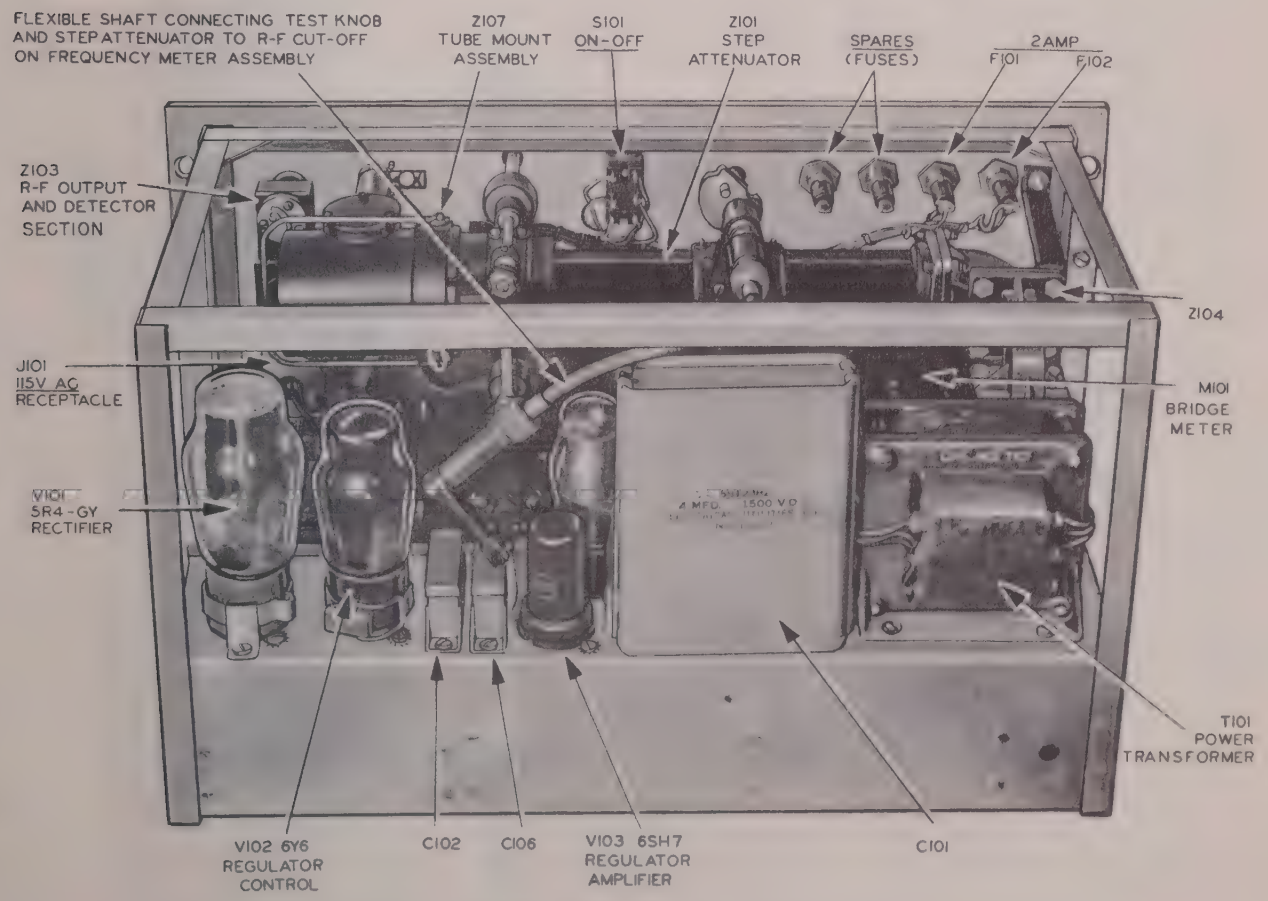


Figure 7—3. Test Set Chassis.

be used as replacements whenever the gaskets are found corroded or are damaged in disassembly of the plumbing system.

c. THERMISTOR MOUNT MX-435/UP.

One calibrated thermistor mount complete with bead and disk thermistors is supplied with each test set. The new thermistor mount is installed by the following method:

(1) Remove the four screws and locknuts which fasten the thermistor mount flange to the FREQUENCY METER flange.

(2) Withdraw the thermistor mount from the chassis.

(3) Unsolder the six chassis wires which connect to the four terminals on one side of the attenuator mount.

(4) Remove the four screws which attach the spare thermistor mount inside the left end of the chassis.

(5) Solder to the thermistor mount the six wires removed in step (3). See the wiring diagram figure 7-14 for color coding.

(6) Place the new gasket against the flange of the new mount and bolt to the fixed attenuator. See that the gasket is oriented properly with respect to the waveguide length and width. The hole in the gasket should coincide with the opening of the waveguide. Be sure to replace the new mount in the same position as the old one.

d. FUSES.

Five spare fuses are supplied to replace the two fuses in primary circuit of the power transformer. For immediate use, two of the spares are contained in the holders marked SPARES on the front panel.

e. CRYSTALS.

Two Navy type 1N23B silicon rectifier crystals are supplied to replace the trigger detector crystal in the r-f output section. The detector crystal is replaced by removing the knurled cap marked CRYSTAL on the control panel and inserting a new crystal cartridge into the cap.

f. LAMPS.

Three 3.0 volt power lamps are supplied to replace the lamp fuse to illuminate the dials on the control panel. The dial lamps in use are removable from the front of the control panel.

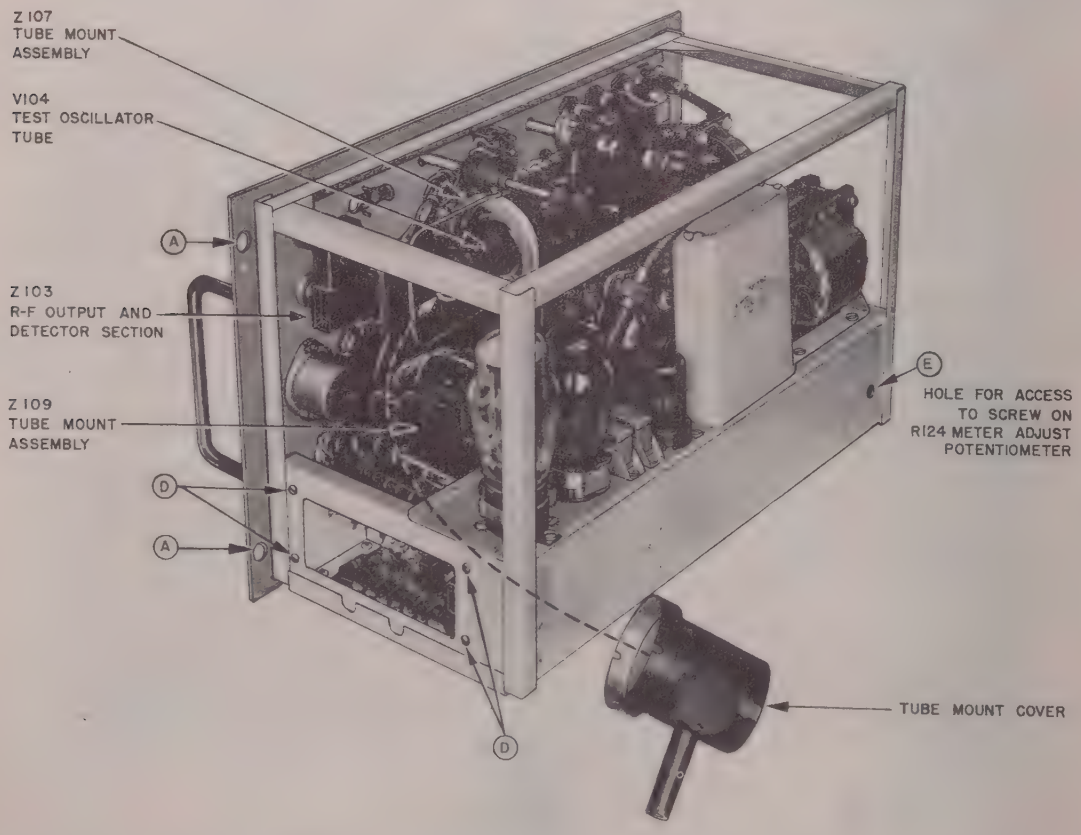


Figure 7—4. Test Set Chassis, Right-end View.

6. ADJUSTMENTS.

a. GENERAL.

The test set contains only two adjustments which can be made by operating personnel without danger of changing the test set calibration. No other adjustments should be attempted in the field.

b. METER ADJUSTMENT POTENTIOMETER R-124.

The purpose of this adjustment is to set the range of the METER BALANCE control so that the meter balance can always be attained. The adjustment is accessible through the hole marked "E" in figure 7-4.

(1) Turn on the test set, allow about five minutes for warm up.

(2) Set the TEST knob to TRAN position.

(3) Set the METER BALANCE control in the middle of its range.

(4) With a screwdriver adjust the METER ADJUST potentiometer until the meter reads BALANCE.

c. SWEEP ADJUST POTENTIOMETER R-142.

The purpose of potentiometer R-142 is to adjust the linearity slope and peak of the sawtooth sweep for the oscillator tube.

(1) Connect an oscilloscope to the reflector of V-104. Trigger both the test set and the start-stop sweep of the oscilloscope together with a suitable trigger source.

(2) Turn on the test set and allow a few minutes for warm up.

(3) Set the SIGNAL WIDTH control to MIN and the PHASE control to MAX.

(4) With a screwdriver, set the SWEEP ADJUST potentiometer so that the sawtooth reaches 100 volts and 50 ms. This setting should produce the most linear sweep obtainable.

7. VOLTAGE MEASUREMENTS.

The voltage measurements listed in the following table are made with the test set operating from a power source of 115 volts ± 10%, 50 to 1600 cycles. Data compiled in this table is measured by a 20,000 ohm per volt voltmeter.

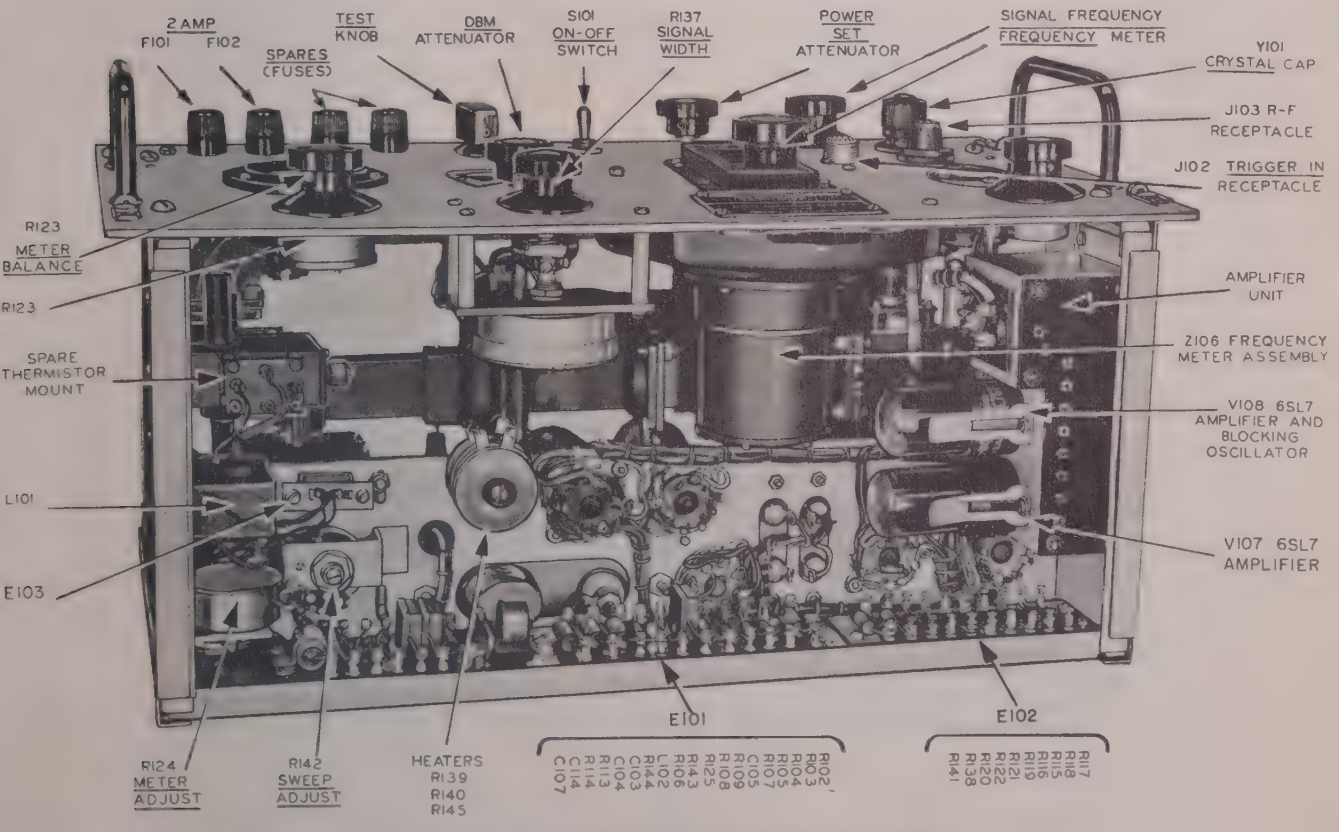


Figure 7—5. Test Set Chassis, Bottom-Front View.

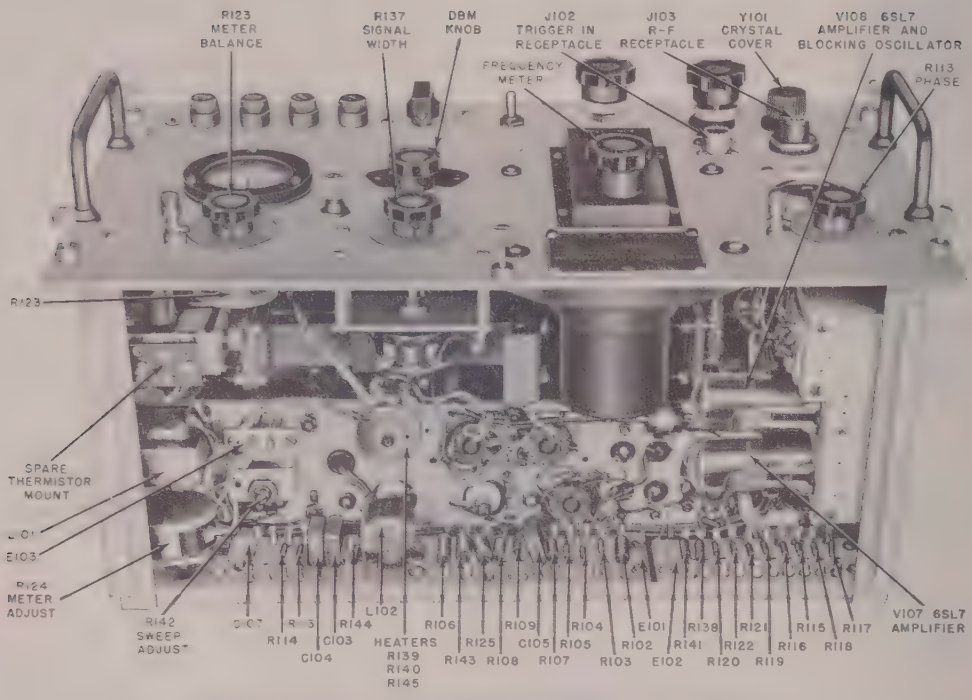


Figure 7—6. Test Set Chassis, Bottom-Rear View.

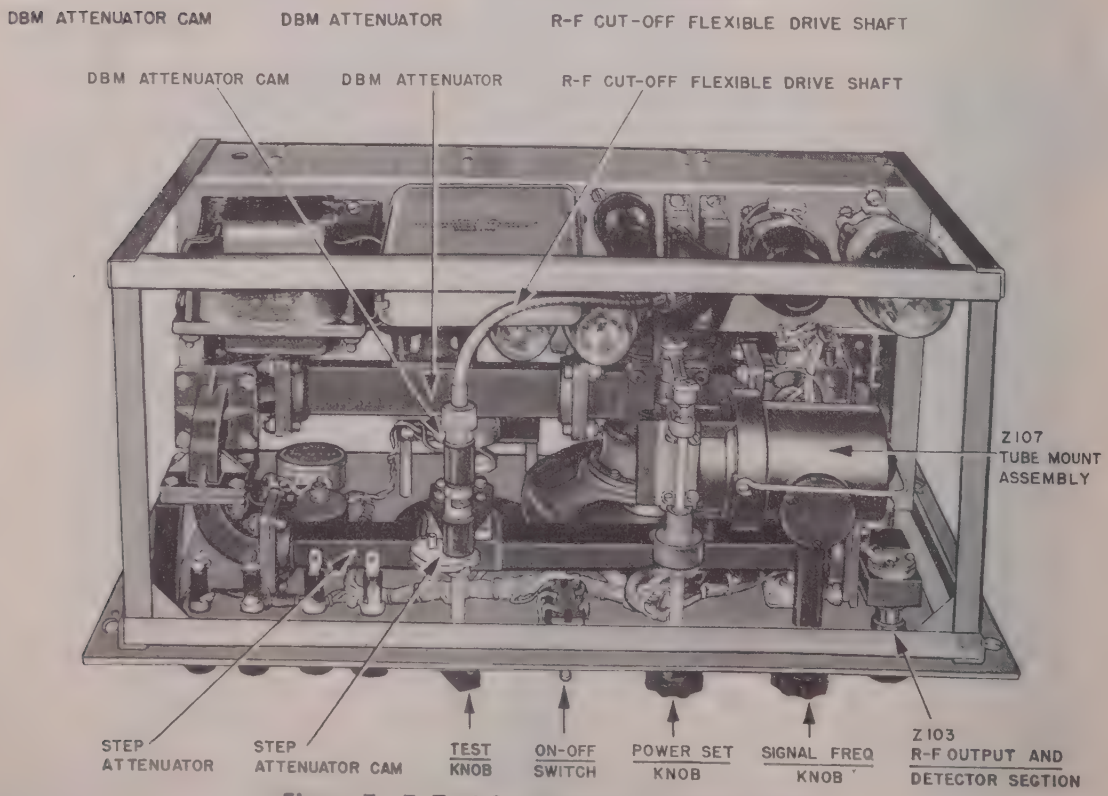
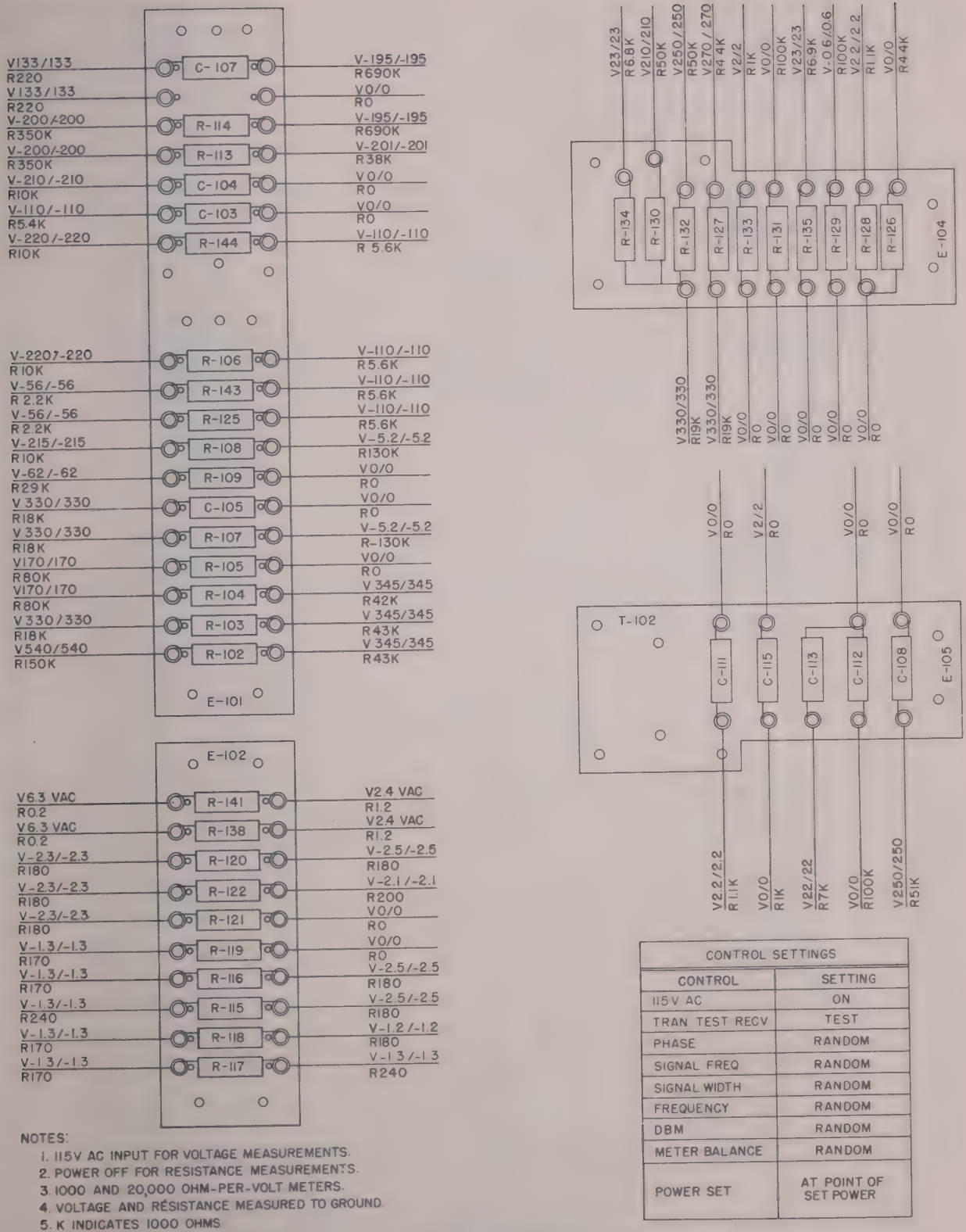


Figure 7—7. Test Set Chassis, Top-Rear View.

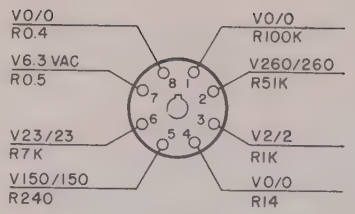


NOTES:
1. 115V AC INPUT FOR VOLTAGE MEASUREMENTS.
2. POWER OFF FOR RESISTANCE MEASUREMENTS.
3. 1000 AND 20,000 OHM-PER-VOLT METERS.
4. VOLTAGE AND RESISTANCE MEASURED TO GROUND.
5. K INDICATES 1000 OHMS

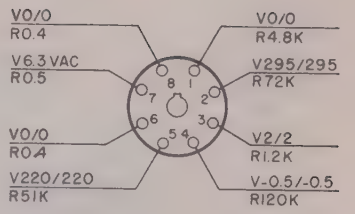
CONTROL SETTINGS	
CONTROL	SETTING
115V AC	ON
TRAN TEST RECV	TEST
PHASE	RANDOM
SIGNAL FREQ	RANDOM
SIGNAL WIDTH	RANDOM
FREQUENCY	RANDOM
DBM	RANDOM
METER BALANCE	RANDOM
POWER SET	AT POINT OF SET POWER

Figure 7—8. Terminal Boards, Voltage and Resistance Diagram.

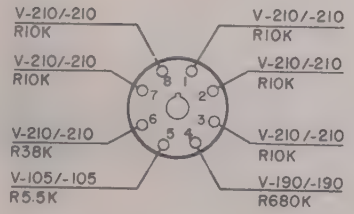
CONTROL SETTINGS			
CONTROL	SETTING	CONTROL	SETTING
115 V AC	ON	SIGNAL WIDTH	RANDOM
TRAN TEST RECV.	TEST	FREQUENCY	RANDOM
SIGNAL FREQ	RANDOM	DBM	RANDOM
PHASE	RANDOM	METER BALANCE	RANDOM
POWER SET-POINT OF SET POWER			



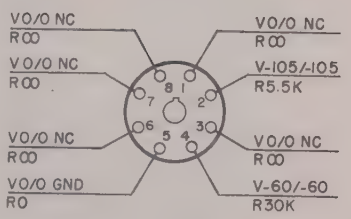
V-108



V-107

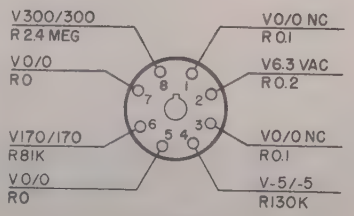


V-106

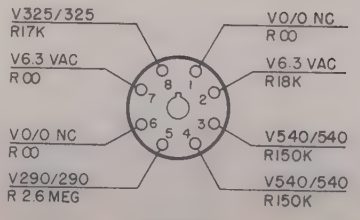


V-105

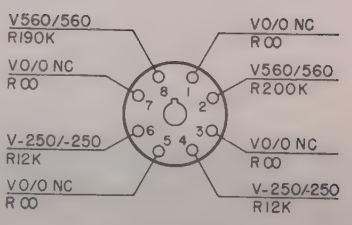
NOTES:
1. 115V AC INPUT FOR VOLTAGE MEASUREMENTS.
2. POWER OFF FOR RESISTANCE MEASUREMENTS.
3. 20,000 OHMS-PER-VOLT METER.
4. VOLTAGE AND RESISTANCE MEASURED TO GROUND.
5. K INDICATES 1000 OHMS.
6. TUBE V-104 IS ENCASED AND VOLTAGE AND RESISTANCE MEASUREMENTS ARE NOT TAKEN.



V-103



V-102



V-101

Figure 7—9. Tube Sockets, Voltage and Resistance Diagram.

8. CURRENT MEASUREMENTS.

a. Bridge current (through R-153) ..... 21 ma.
b. Amplifier current (general 1) ..... 18 ma.
c. Oscillator V-104 current (terminal 4, Z-107) ma.
16 to 32 ma.

9. RESISTANCE MEASUREMENTS.

The resistance measurement listed in the following table are made with the test set turned off and the power cable disconnected from the power source. Measurements on the thermistor mount Z-109 may vary as much as 25% from the values listed because of variations in these thermistors.

10. FIELD CALIBRATION ON TEST SET TS-147C/UP.

a. Compare the test set with at least two other TS-147C/UP sets or similar test sets. If the test set is questionable return the set to the nearest electronics officer.

TABLE 7-1. TUBE CHARACTERISTICS

TUBE TYPE	HEATER VOLTAGE (V)	HEATER CURRENT (A)	PLATE VOLTAGE (V)	GRID BIAS (V)	SCREEN VOLTAGE (V)	PLATE CURRENT (MA)	SCREEN CURRENT (MA)	AC PLATE RESISTANCE (OHMS)	VOLTAGE AMPLIFICATION FACTOR (MU)	TRANSCONDUCTANCE Micromhos		EMISSION	
										Normal	Minimum	Is	TEST VOLT
5R4GY	5.0	2.0										400	75
6Y6G	6.3	1.25	200	−14	135	66	9	9,300-18,300		7100	7000		
6SH7	6.3	0.3	250	−5.5	150	10.8	4.1	90,000		4900	4000	95	20
2K25	6.3	0.45	300										
OC3/VR-105	gaseous voltage regulator, starting voltage 133 min, operating voltage 105 (approx) operating current 5 (min) to 40 (max)												
6SL7-GT	6.3	0.3	250	−2		2.3		44,000	70	1600	1200	40	30

TABLE 7-2. ELECTRON TUBE OPERATING VOLTAGES

SYMBOL	TUBE TYPE	FUNCTION	PLATE VOLTS	SCREEN VOLTS	SUPP. VOLTS	CATH. VOLTS	GRID VOLTS	HTR VOLTS
V-101	5R4GY	Voltage rectifier	−250 pin 4 −250 pin 6					560 pin 2 560 pin 8
V-102	6Y6G	Regulator control	540	540	325	325	290	6.3
V-103	6SH7	Regulator amplifier	300	170	0	0	−5	6.3
V-104	2K25	Test oscillator	195			0	330	6.3
V-105	OC3/VR-105	Voltage regulator	−105					
V-106	OC3/VR-105	Voltage regulator	−105					
V-107	6SL7-GT	Amplifier	295 pin 2 220 pin 5			2.0 pin 3 0 pin 6	0 pin 1 −0.5 pin 4	6.3
V-108	6SL7-GT	Amplifier	260 pin 2 150 pin 5			2.0 pin 3 23 pin 6	0. pin 1 0. pin 4	6.3

115 v AC	ON	DBM	−80
TRAN TEST RECV	TEST	PHASE	Max.
METER BALANCE	SET POWER	SIGNAL WIDTH	Min.

TABLE 7-3. WINDING DATA

DESIGNATION SYMBOL	ESPEY PART No.	DIAGRAM	WINDING	WIRE SIZE	No. OF TURNS	DC RESISTANCE IN OHMS	HIPOT AC VOLTS
L-101	B16.317-B		Multiple	#37	2200	365	2500
L-102	B16.318-B		Multiple	#36	2970	232	1800
T-101	B18.114-C		Primary	#23	365	3.60	1500
			Sec. #1	#37	6000	1875	2750
			Sec. #2	#22	22	0.25	1500
			Sec. #3	#21	18	0.16	1500
			Sec. #4	#25	22	0.17	1500
T-102	B15.104-B		Primary	#33	90	2.32	1000
			Sec. #1	#33	90	2.46	1000
			Sec. #2	#38	135	12.4	1000

11. SUPPLEMENTARY DATA

a. MEASURING PICK-UP HORN SPACE LOSS.

(1) Space loss of the pick-up horn can be measured by comparison to the loss in a directional coupler. This method can be used only if a directional coupler can be installed in the type of system under test. Once the space loss for a particular type of system is determined, it is unlikely that such a measurement will have to be repeated again for each system of that type, provided that the same horn distance is always used and that the distance chosen is not critical.

(2) Connect the test set as shown in figure 4-2 and follow steps (2) through (5) of paragraph 5.*b.* in Section 4. Record the DBM dial reading.

(3) Connect the test set as shown in figure 4-3 and follow steps (2) through (5) of paragraph 5.*b.* in Section 4. Orient the horn for maximum DBM dial reading. Add the least critical convenient distance is found. Set the power and record the DBM dial reading.

Note

The distance between the antenna and the horn should be from about three to five feet, the best distance depending upon the radar system being tested. At some distances the coupling is critical to distance, e.g., the coupling varies greatly for small changes in distance. The best position for the horn is at the distance where this effect is minimized.

(4) The space loss for the horn and the particular radar system is the difference between the DBM dial readings obtained in steps (2) and (3) above.

(5) For reference, the space loss and the distance used should be recorded in the following table.

Radar System	*D*	*H*	*Polarization*	*Space Loss*

D = Horizontal distance between antenna dipole and pick-up horn.
H = Vertical distance from line-of-sight of antenna.

b. MEASURING R-F CABLE ATTENUATION.

(1) If the r-f cable becomes damaged or has been repaired, the calibration of the cable has probably changed. A new attenuation calibration can be made by the following method.

(2) Connect the test set as shown in figure 4-2. Follow steps (2) through (5) of paragraph *5.b.* in Section 4. Record the reading of the DBM dial.

(3) Connect the unknown r-f cable in series with the cable used in step (2) by means of a UG-29B/U or a UG-30B/U connector contained in Maintenance Kit MK-47/UPM.

(4) Repeat step (2).

(5) The attenuation of the unknown cable added in step (3) is equal to the difference between the DBM dial readings obtained in steps (2) and (4).

c. ALTERNATE RECEIVER TUNING PROCEDURE.

This CW procedure does not require an A or J-scope, but is not as accurate as the procedure of Section 4, paragraph *4.k.*

(1) PREPARE RADAR AND TEST SET.—Perform the following operations, if not already performed:

Operation	*Paragraph*
Prepare Radar	*4.a.*(1)
Prepare TS-147C/UP	*4.a.*(2)

(2) ADJUST RADAR RECEIVER.—Set radar on manual tuning. Set gain high enough to show small amount of noise.

(3) SET TS-147C/UP FOR RCVR TEST.—Set TEST knob to RCVR; DBM knob to about —50 dbm; POWER SET knob near maximum (clockwise); PHASE knob near mid position.

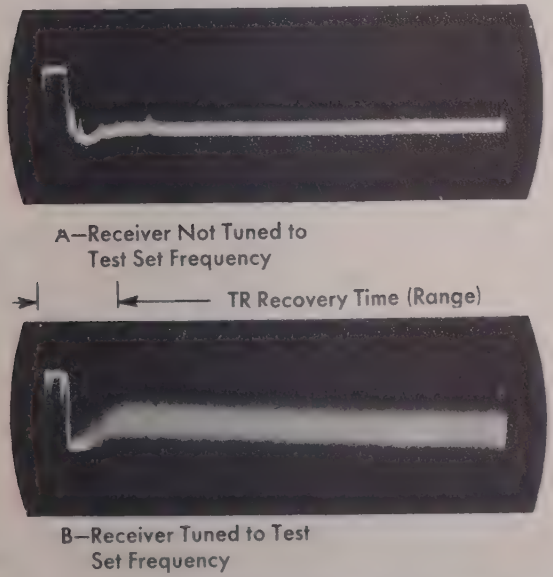


Figure 7—10. Receiver Tuning on CW and Alternate Method of Checking TR Recovery.

(4) TUNING RECEIVER TO TRANSMITTER (OR BEACON) FREQUENCY.

(a) SET TS-147C/UP ON CW.—Turn SIGNAL WIDTH knob clockwise to CW. Maximize meter reading with PHASE control. Leave TEST on RCVR, set DBM to about —50 dbm.

(b) SET TS-147C/UP TO TRANSMITTER (OR BEACON) FREQUENCY. — Adjust SIGNAL FREQ knob to transmitter (or beacon) frequency resetting PHASE knob when meter drops 10%, checking frequency by dipping meter with FREQUENCY control.

(c) DETUNE RECEIVER LOCAL OSCILLATOR.—Set radar on manual tuning. Set local oscillator at extreme end of tuning range, but on correct side of transmitter (or beacon) frequency. Adjust local oscillator for crystal current.

(d) TUNE RECEIVER TO TS-147C/UP.—Tune receiver local oscillator mechanical tuning slowly toward center of its range, resetting the reflector voltage when crystal current drops, watching for CW signal on oscilloscope (intensified range sweep on PPI or B-scope, increased noise level on A or J-scope). See figure 7-10 for A-scope presentation. Tune mechanical tuner of receiver for maximum C-W signal, decreasing setting of DBM attenuator, if necessary, to prevent saturation.

(5) ADJUST RADAR R-F COMPONENTS.—Tune TR and ATR for maximum TS-147C/UP signal. Adjust DBM attenuator to avoid flat topped signal while tuning. Adjust crystal current for proper value. Readjust L-O, TR, and ATR to compensate for interaction.

d. ALTERNATE TR RECOVERY CHECK.

The CW procedure is useful in special cases where the TR recovery time is short and it is not possible to phase the signal all the way into the transmitter pulse.

(1) OBTAIN CW SIGNAL.—Use any of the following alternate procedures:

(a) BROADEN FM SIGNAL OUT TO CW SIGNAL.—After any of the following places: Section 4, paragraphs *4.d.*(3), *4.d.*(4), *4.e, 4.f, 4.f.*(3), *4.h, 4.i,* or *4.k.* Detune FREQUENCY meter, turn SIGNAL WIDTH knob clockwise to CW, while holding signal in sight with PHASE knob.

(b) USE CW SIGNAL PREVIOUSLY OBTAINED.—Start after any of the following places:

Section 4, paragraph *4.f.*(6) or *4.k.*(4).
Section 7, paragraph (3).

(2) SET SIGNAL HEIGHT (See figure 7-10 B).—Tune SIGNAL FREQ. knob for maximum height, keeping signal below saturation.

(3) OBSERVE TR RECOVERY TIME. — Observe the range (time) at which the noise height (grass) starts to decrease (see figure 7-10 B).

e. MEASURING AVERAGE TRANSMITTER POWER BELOW +10 DBM.

When transmitter power entering the test set is between

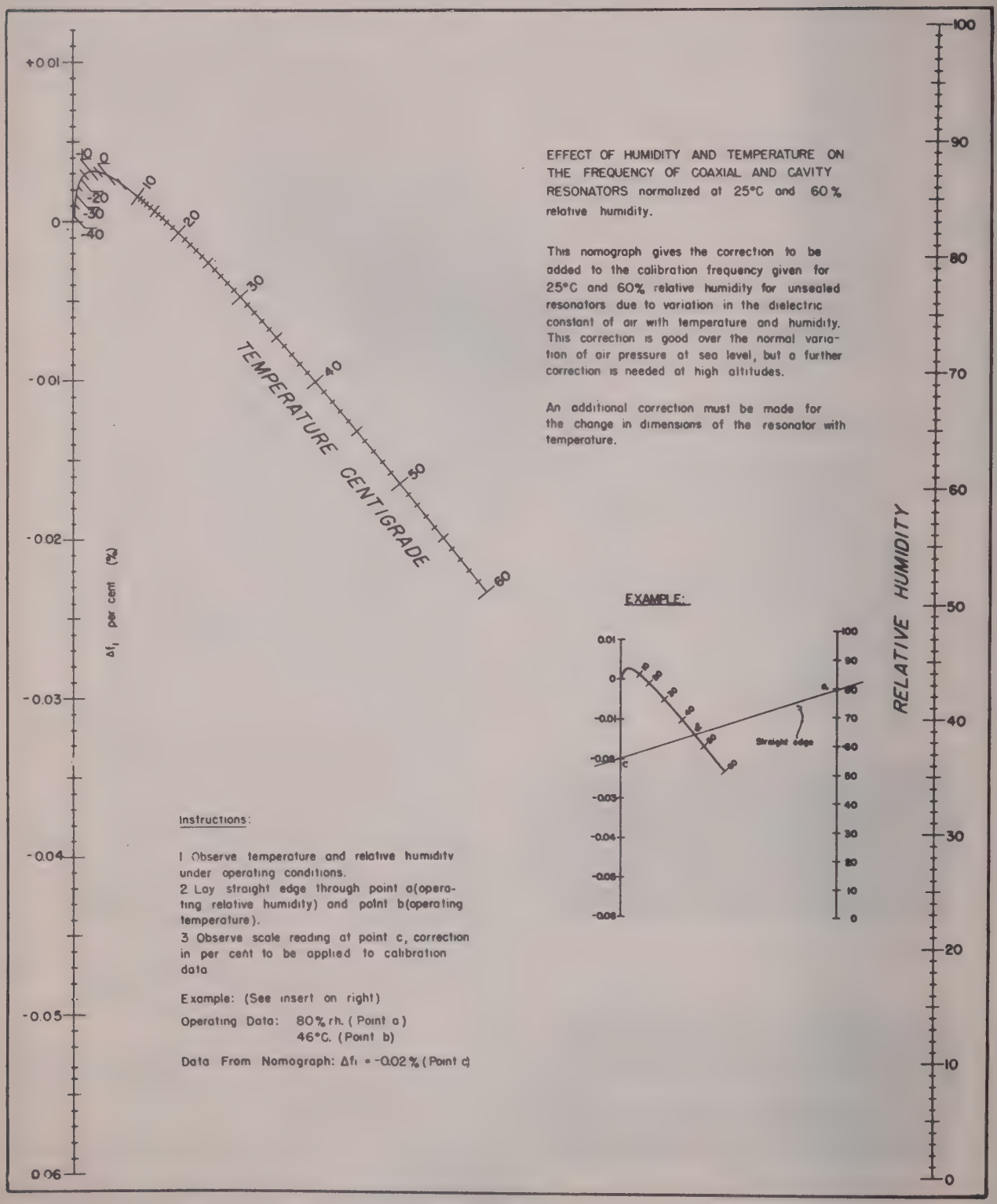

EFFECT OF HUMIDITY AND TEMPERATURE ON THE FREQUENCY OF COAXIAL AND CAVITY RESONATORS normalized at 25°C and 60% relative humidity.
This nomograph gives the correction to be added to the calibration frequency given for 25°C and 60% relative humidity for unsealed resonators due to variation in the dielectric constant of air with temperature and humidity. This correction is good over the normal variation of air pressure at sea level, but a further correction is needed at high altitudes.
An additional correction must be made for the change in dimensions of the resonator with temperature.
TEMPERATURE CENTIGRADE
RELATIVE HUMIDITY
Δf1 per cent (%)
+0.01
0
-0.01
-0.02
-0.03
-0.04
-0.05
-0.06
-10
0
10
20
30
40
50
60
70
80
90
100
EXAMPLE:
Straight edge
Instructions:
1 Observe temperature and relative humidity under operating conditions.
2 Lay straight edge through point a(operating relative humidity) and point b(operating temperature).
3 Observe scale reading at point c, correction in per cent to be applied to calibration data
Example: (See insert on right)
Operating Data: 80% rh. (Point a)
46°C. (Point b)
Data From Nomograph: Δf1 = -0.02% (Point c)

Figure 7—11. Frequency Meter Corrections for Dielectric Changes Due to Temperature and Humidity.

+1 and +10 dbm, the following procedure may be used. The regular procedure of Section 4, paragraph *4.b.* or *5.b.* is recommended when power entering the test set is between +7 dbm and +30 dbm.

(1) CONNECT TS-147C/UP TO RADAR.—Connect R-f Cable CG-92A/U from RF receptacle to radar directional coupler (or test horn) as in figure 4-2 (or 4-3). Set TEST knob to TRAN and set DBM knob all the way counter-clockwise.

(2) TURN ON TS-147C/UP.—Connect 115V AC receptacle to power line with Power Cord CX-337/U. Turn 115V AC switch to ON and wait two minutes.

(3) BALANCE METER. — With TEST to TRAN and DBM full counter-clockwise, adjust METER BALANCE until meter is at BALANCE.

(4) SET DBM DIAL.—Turn DBM dial clockwise to end of travel. Then set DBM dial carefully to +10 dbm.

(5) OBSERVE POWER. — Read the meter to get power entering the test set in milliwatts. The BALANCE point is zero milliwatts, SET POWER point is 10 milliwatts, and each division represents an increase of one milliwatt.

(6) CONVERT TO DBM.–Convert power entering the test set from milliwatts to dbm by use of figure 4-8.

(7) COMPUTE TRANSMITTER AVERAGE POWER.—Compute as follows:

$P_{av(dbm)} = +T'_{(dbm)} + A_{(db)} + C_{(db)}$

$P_{av(dbm)}$ = Transmitter Average Power (in decibels above one milliwatt).

$T'_{(dbm)}$ = Average r-f power entering the test set (in dbm). Obtained in step (6).

$A_{(db)}$ = Total attenuation of cable and external attenuators (if any) between test set and directional coupler (or horn) in decibels. Cable loss is usually marked on cables supplied with test set.

$C_{(db)}$ = Coupling of directional coupler in decibels (or space loss between radar antenna and horn).

Example: In step (5), meter reads 4 divisions from BALANCE point.
$T' = 4$ milliwatts.
From figure 4-8, $T' = +6$ dbm.
$P_{av(dbm)} = +6 + 4 + 20 = +30$ dbm.

f. TEMPERATURE AND HUMIDITY CORRECTIONS FOR FREQUENCY METER.
(Figures 7-11 and 7-12.)

Note

The accurate results which the following corrections produce are seldom necessary in field use except for tuning the beacon local oscillator.

CAUTION

THE TEMPERATURE AND RELATIVE HUMIDITY SPECIFIED REFER TO THE CONDITIONS OF THE FREQUENCY METER CAVITY. THESE CONDITIONS MAY BE DIFFERENT FROM THE EXTERNAL ATMOSPHERIC CONDITION.

(1) DETERMINE CORRECTION FOR DIELECTRIC CHANGE. (Use figure 7-11.)

Example: At 46°C, 80% rh, $\Delta f_1 = -0.02\%$

(2) DETERMINE CORRECTION FOR DIMENSIONAL CHANGE. (Use figure 7-12.)

Example: At 46°C, $\Delta f_2 = -0.013\%$

(3) COMBINE CORRECTIONS.—Add Δf_1 and Δf_2 algebraically.

Example: $\Delta f = \Delta f_1 + \Delta f_2 = -0.033\%$

(4) CORRECT FREQUENCY OR DIAL READING.

(a) TO CORRECT OBSERVED FREQUENCY.—Convert Δf from percent to megacycles and add Δf (mc) to observed frequency.

Example: $\Delta f = -0.033\%$
FREQUENCY dial reading = 938.2
observed frequency,
$f_o = 9382$ mc

$$f = f_o + (\Delta f)\frac{f_o}{100}$$

$$f = 9382 - 0.033 \times \frac{9382}{100}$$

$f = 9382 - 3.1 = 9378.9$ mc.

(b) TO CORRECT DESIRED FREQUENCY DIAL SETTING.—Convert Δf from percent to megacycles and subtract Δf(mc) from nominal dial reading to obtain desired frequency setting.

Example: f = Frequency desired = 9310 mc.

$\frac{f_o}{10}$ = FREQUENCY dial reading

$f_o = f - \Delta f$

$\Delta f = -3.1$ mc

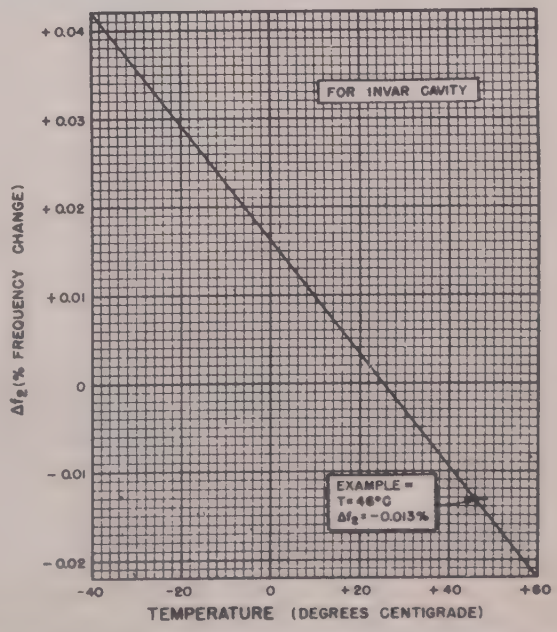


Figure 7—12. Frequency Meter Corrections for Dimensional Changes Due to Temperature.

$$f_o = 9310 - (-3.1) = 9310 + 3.1$$
$$f_o = 9313.1 \text{ Mc}$$

$$\text{FREQUENCY dial reading} = \frac{f_o}{10} = \frac{9313}{10} = 931.3$$

g. MEASURING CW SIGNAL EQUAL TO NOISE.

Note

The c-w signal equal to noise is a measure of receiver sensitivity used in bench testing. It is related to, but not equal to, the receiver performance figure (minimum discernible signal power) used in field measurements.

(1) CONNECT METER TO SECOND DETECTOR.—Connect a voltmeter from the cathode of the second detector tube of the radar receiver to ground.

(2) CALIBRATE SECOND DETECTOR.

(a) OBTAIN CALIBRATED C-W SIGNAL.—Perform the following operation, if not already performed:

Operation	*Section-Paragraph*
Prepare Radar, Test Set and Oscilloscope	4-4.*f*.(1)
Adjust Radar Receiver	4-4.*f*.(2)
Tune Test Set to Receiver	4-4.*f*.(3)
Check Meter Balance	4-4.*f*.(4)
Find Signal Again	4-4.*f*.(5)
Set Signal Power on c-w	4-4.*f*.(6)

(b) ADJUST RECEIVER GAIN.—Turn receiver gain down and then increase gain until meter deflection starts to increase.

(c) CALIBRATE SECOND DETECTOR.—Turn DBM dial in one db steps, recording DBM dial reading and corresponding meter reading at second detector cathode. Plot DBM dial reading against meter deflection on graph paper to get calibration curve of meter reading vs. db. As an approximation, this may be assumed the constant for the same type radar.

(3) SET NOISE LEVEL.—With test set DBM dial set to maximum attenuation, turn receiver gain to a convenient level (less than half of saturation) and observe second detector meter reading.

(4) MEASURE C-W SIGNAL EQUAL TO NOISE.

(a) COMPUTE DESIRED METER READING.—From the calibration curve obtained in paragraph *5.b.*(3) determine the meter reading corresponding to 3 db above the noise level reading obtained in paragraph *5.c.*

(b) RESTORE C-W SIGNAL.—Adjust DBM dial to restore c-w signal obtained in paragraph *11.g.*(2).*(a)*.

(c.) SET C-W SIGNAL TO EQUAL NOISE.—Adjust DBM knob until meter reading computed in paragraph *11.g.*(4).*(a)* is obtained. Observe DBM dial reading.

(d) COMPUTE C-W SIGNAL EQUAL TO NOISE.

$$P_{new\,(dbm)} = (M_{(dbm)} - A_{(db)} - C_{(db)})$$

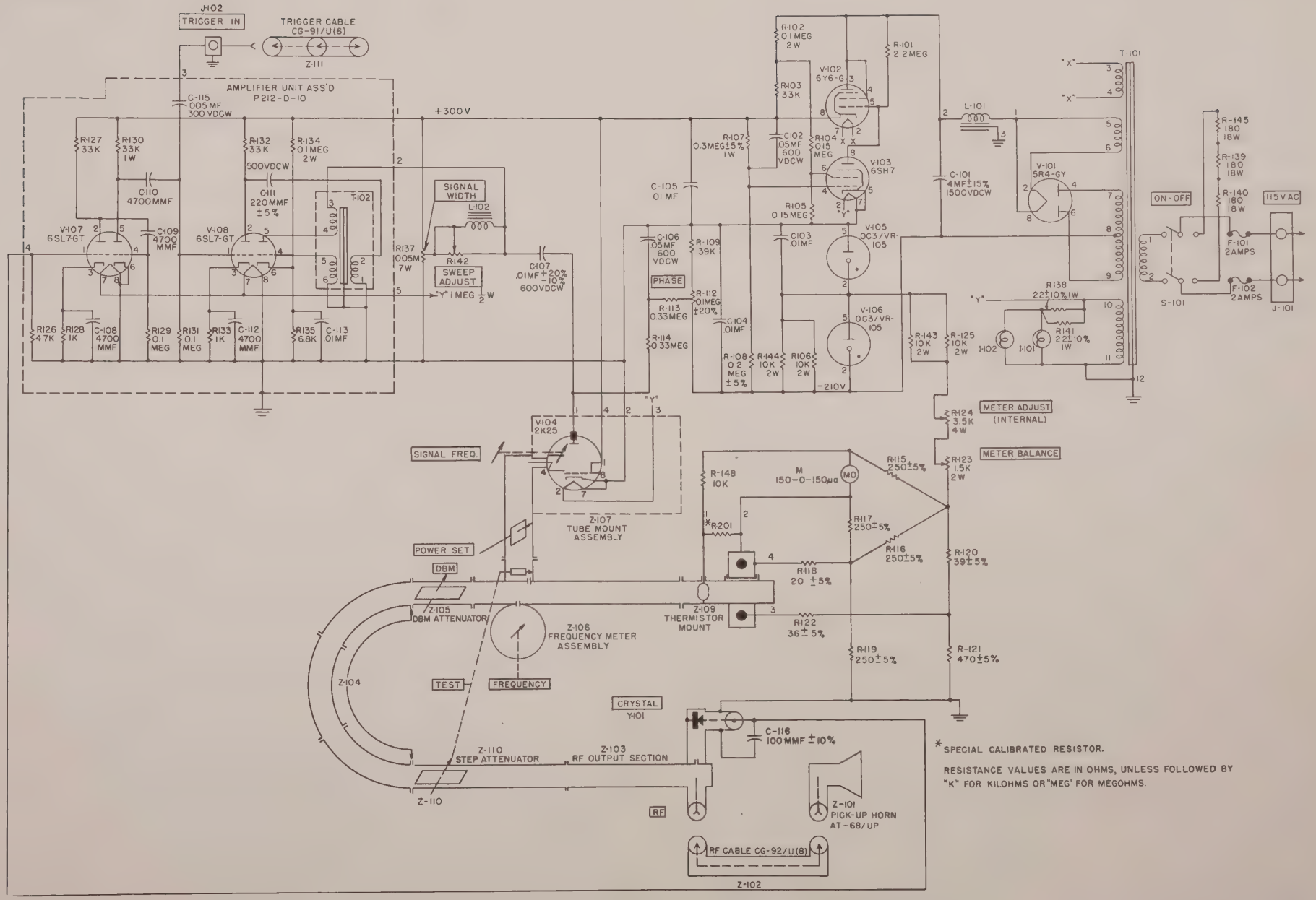
where:

$P_{new\,(dbm)}$ = Continuous wave power input to radar which produces power level at second detector equal to noise.

$M_{(dbm)}$ = Peak power output of the test set in dbm.

$A_{(db)}$ = Total attenuation of cable and external attenuators (if any) between test set and directional coupler (or horn) in decibels.

$C_{(db)}$ = Coupling of directional coupler in decibels (or space loss between radar antenna and horn).



*SPECIAL CALIBRATED RESISTOR.

RESISTANCE VALUES ARE IN OHMS, UNLESS FOLLOWED BY "K" FOR KILOHMS OR "MEG" FOR MEGOHMS.

Figure 7—13. **Test Set TS-147C/UP Schematic Diagram**

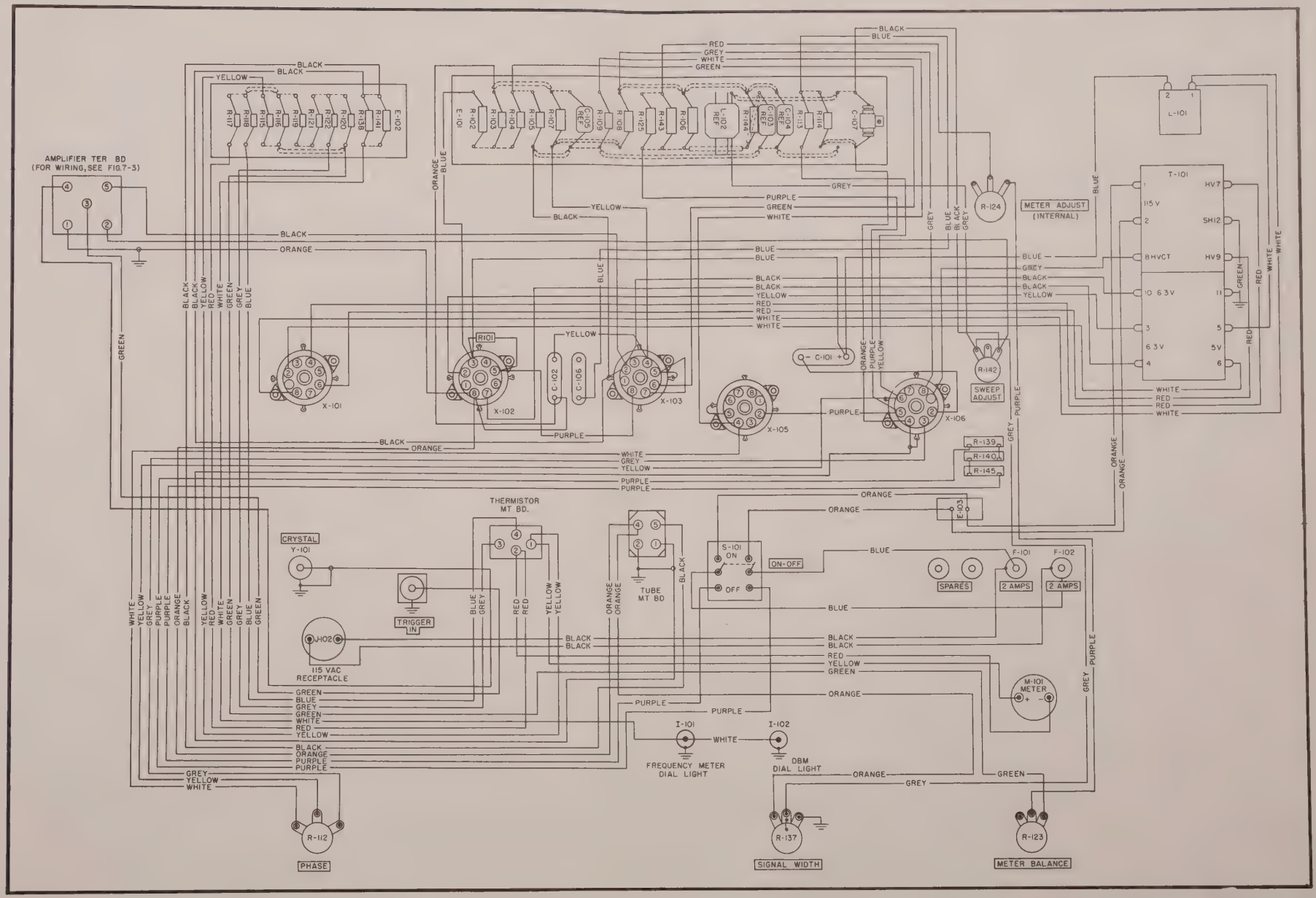
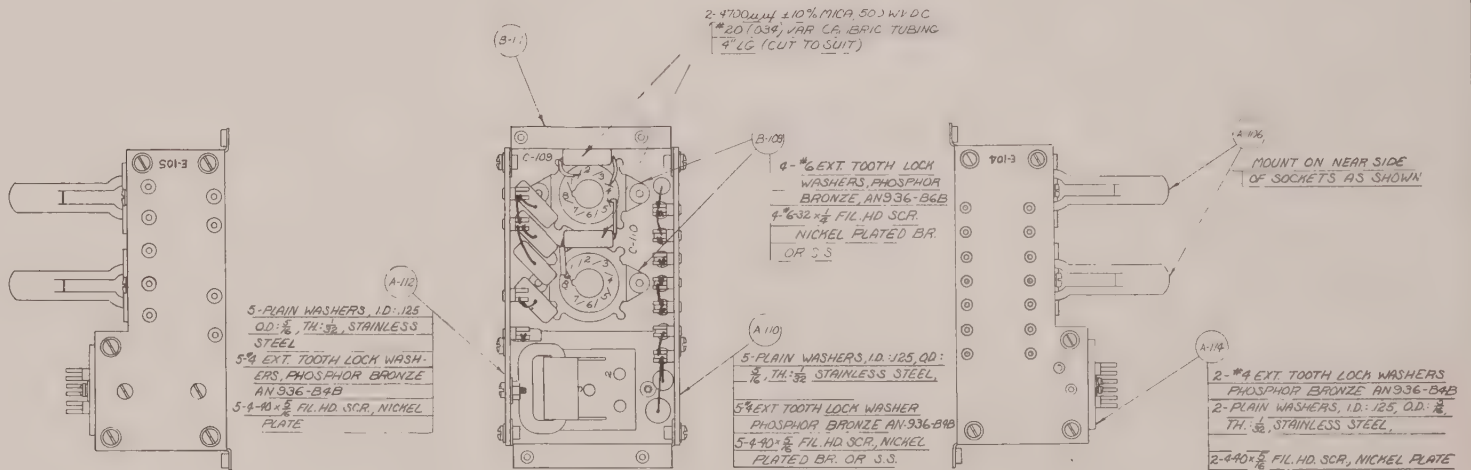
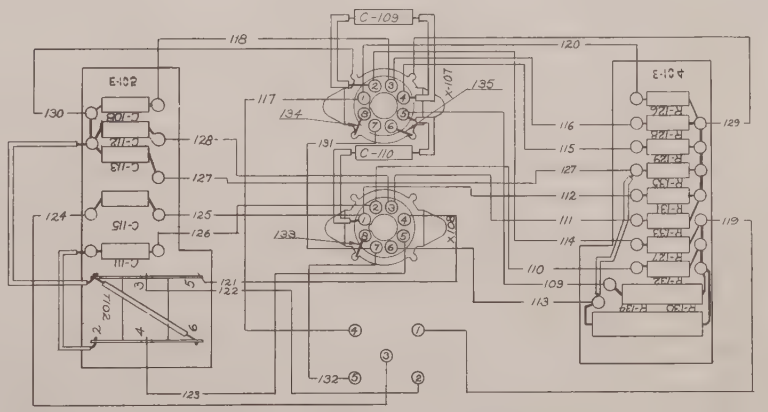


Figure 7—14. **Power Supply Chassis and Control Panel Wiring Diagram**


2-4700 μμf ±10% MICA 500 W.V.D.C.
#20 (.032) VAR. CAMBRIC TUBING 4" LG (CUT TO SUIT)
4-#6 EXT. TOOTH LOCK WASHERS, PHOSPHOR BRONZE, AN936-B6B
4-#6-32 x 1/4 FIL. HD. SCR. NICKEL PLATED BR. OR S.S.
MOUNT ON NEAR SIDE OF SOCKETS AS SHOWN
5-PLAIN WASHERS, I.D.: .125, O.D.: 5/16, TH.: 1/32, STAINLESS STEEL
5-#4 EXT. TOOTH LOCK WASHERS PHOSPHOR BRONZE AN936-B4B
5-4-40 x 5/16 FIL. HD. SCR., NICKEL PLATE
5-PLAIN WASHERS, I.D.: .125, O.D.: 5/16, TH.: 1/32 STAINLESS STEEL
5-#4 EXT TOOTH LOCK WASHER PHOSPHOR BRONZE AN936-B4B
5-4-40 x 5/16 FIL. HD. SCR., NICKEL PLATED BR. OR S.S.
2-#4 EXT. TOOTH LOCK WASHERS PHOSPHOR BRONZE AN936-B4B
2-PLAIN WASHERS, I.D.: .125, O.D.: 5/16, TH.: 1/32, STAINLESS STEEL,
2-4-40 x 5/16 FIL. HD. SCR., NICKEL PLATE
E-105
E-104
C-109
C-110
A-112
A-110
A-114
B-109

WIRE DATA

RUN #	TERMINATION FROM:	TERMINATION TO:	COLOR	LENGTH	SPECIFICATIONS
109	R-130	X-107-5	ORANGE	5 1/4"	
110	R-132	X-108-2 ④	RED	4 3/8"	
111	R-133	X-108-3	VIOLET	3 5/8	
112	R-131	X-108-1 ④	YELLOW	4	
113	R-134	X-108-6	GREEN	3 7/8	
114	R-127	X-107-2	BLUE	5 5/8	
115	R-129	X-107-4	BLACK	5 3/8	
116	R-128	X-107-3	GREEN	3 1/2	
117	X-107-1	TERMINAL #4	WHITE	5 1/2	
118	C-108	X-107-3	GREEN	3 1/4	
119	* ③	TERMINAL #1	ORANGE	5 5/8	#20 AWG
120	R-126	X-107-1	WHITE	3 3/4	
121	T-102-5	X-108-4	BLUE	3 5/8	
122	T-102-3	TERMINAL #2	RED	3 5/8	
123	T-102-4	X-108-5	GREY	4 1/8	
124	C-115	TERMINAL #3	YELLOW	5 5/8	
125	C-115	X-108-1	YELLOW	3 1/8	
126	C-111	X-108-2	RED	3 1/2	
127	C-113	R-135	GREEN	4 1/8	
128	C-112	X-108-3	VIOLET	3 1/8	
129	**	GROUND	WHITE	4	
130	C-108, C-112, C-113	GROUND	WHITE	3 3/4	#18 AWG
131	X-107-7	X-108-7	WHITE	3 5/8	
132	X-108-7	TERMINAL #5	WHITE	4 1/8	
133	X-108-8	GROUND	BUS		
134	X-107-8	GROUND	BUS		#20 AWG
135	X-107-6	GROUND	BUS		



WIRING DIAGRAM

FINISH: MOISTURE AND FUNGUS RESISTANT TREATMENT WITH FLUORESCENT DYE ALL OVER EXCEPT CONTACTS ON TUBE SOCKETS & TERMINALS ON TERMINAL BLOCK

* R-127, R-130, R-132, R-134

** R-126, R-128, R-129, R-131, R-133, R-135

Figure 7—15. Amplifier Unit Wiring Diagram

SECTION 8

PARTS LIST

TABLE 8-1. LIST OF MAJOR UNITS

SYMBOL GROUP	NAME OF MAJOR UNIT	NAVY TYPE	DESIGNATION
100-199	Test Set		TS-147C/UP

TABLE 8-2. COMBINED PARTS AND SPARE PARTS LIST

REFERENCE DESIGNATION	STOCK NO., SIG. CORP. STANDARD NAVY AND AIR FORCE	NAME AND DESCRIPTION	LOCATING FUNCTION
A-101		CASE: to carry Test Set TS-147C/UP: 52S aluminum per QQ A-318 with light gray enamel per spec MIL-E-15090 (Ships) Type III, Class 1; p/o Test Set AN type TS-147C/UP with space for carrying the following components: test set unit, 1 horn pickup AN type AT-68/UP, 1 RF cable assembly AN type CG-92A/U (8), 1 trigger cable assembly AN type CG-638/U (6), 1 power cable assembly Espey part/dwg no. B13.158, 1 handbook of maintenance instructions Navy Publication Nav Ships, 3 spare panel lamps Espey part/dwg no. 31.059, 2 spare silicon diode crystals JAN type no. 1N23B, 1 spare thermistor mount Navy type MX-435/UP, 9 spare gaskets Espey part/dwg no. A27.3660, 5 spare fuse cartridges Navy type no. 28032-2; 19½ in. lg x 11⅞ in. wd x 12$\frac{13}{16}$ in. h overall, 1 flush folding type handle located on top cover assembly; removable top cover with hinged inner plate covering strip mounting for carrying spare lamps, fuses, gaskets, and pickup horn; AN Test Set TS-147C/UP; Espey Mfg. Co. part/dwg no. N22.622 and N22.639	Carrying case for test set
A-102		HORN, pickup: Army-Navy type no. AT-68/UP, aluminum alloy AL360, cast, black anodize finish per spec AN-QQ-A-696; approx funnel shaped with right angle elbow; 3$\frac{31}{32}$ in. lg x 1 in. wd x 1$\frac{7}{32}$ in. d o/a; Espey Mfg. Co. part/dwg no. B27.3846	Pickup horn
C-101	3DB4-296 16-C-49962-8969 3330 317 643 038	CAPACITOR, fixed: paper dielectric; JAN type CP70E1DH-405K; single sect; 4 mf ± 10%; 1500 vdcw; hermetically sealed metal case; 3¾ in. lg x 1¼ in. wd x 4¾ in. h, excluding term and mtgs; mineral oil impregnated; two no. 10-32 x 1 in. stud term; no internal ground connections; 2 spade lug mtg brackets; Espey part no. 25.606; per spec JAN-C-25	Filter for V-102 and V-103
C-102	3DA50-217 3330 316 263 390	CAPACITOR, fixed: paper dielectric; JAN type CP69B1EF-503K; single sect; 50000 mmf ± 10%; 600 vdcw; hermetically sealed metal can; 1¾ in. lg x $\frac{31}{64}$ in. wd x 1$\frac{1}{16}$ in. h; mineral oil impregnated; 2 solder lug term. on bottom 1 in. C to C; no internal ground connections; 2 chanel type mtg brackets, 2⅛ in. mtg centers; Espey part no. 25.607; per spec JAN-C-25	Thermionic noise bypass grid of V-103

TABLE 8-2. COMBINED PARTS AND SPARE PARTS LIST—Continued

REFERENCE DESIGNATION	STOCK NO., SIG. CORP. STANDARD NAVY AND AIR FORCE	NAME AND DESCRIPTION	LOCATING FUNCTION
C-103	3K35 10311 16-C-33622-5227 3330 376 144 100	CAPACITOR, fixed: mica; JAN type CM35C103K; 10000 mmf ± 10%; 300 vdcw; temp coef letter C; 53/64 in. lg x 53/64 in. wd x 1/32 in. thk; molded bakelite case; 2 axial wire lead term; Espey part no. 25.602; per spec JAN-C-5	Filter bypass V-105
C-104		Same as C-103	Bypass V-105
C-105		Same as C-103	Cathode bypass V-102
C-106		Same as C-102	Bypass phase control
C-107	3DA10-484 16-C-42761-9100 3330 317 680 913	CAPACITOR, fixed: paper dielectric; JAN type CP29A1EF-103V; single sect; 10000 mmf± 20%—10%; 600 vdcw; hermetically sealed metal can; 1 1/8 in. lg x 7/16 in. diam. excluding term; mineral oil impregnated; 2 axial wire lead term; no internal ground connections; mts by one bracket wrapped around capacitor with a 5/32 in. mtg hole centered 1/2 in. from ends; Espey part no. 25.608; per spec JAN-C-25	Coupling V-108 and V-104
C-108	3K35 47241 16-C-32646-6818 3330 576 151 835	CAPACITOR, fixed: mica dielectric; JAN type CM35D472K; 4700 mmf ± 10%; 500 vdcw; temp coef letter D; 53/64 in. lg x 53/64 in. wd x 1/32 in. thk; molded bakelite case; 2 axial wire leads; Espey part no. 25.603; per spec JAN-C-5	Cathode bypass V-107
C-109		Same as C-108	Coupling V-107A and V-107B
C-110		Same as C-108	Coupling V-107B and V-108A
C-111	3K2022142 16-C-29370-7606 3330 376 017 410	CAPACITOR, fixed: mica; JAN type CM20D221J; 220 mmf ± 5%; 500 vdcw; temp coef letter D; 53/64 in. lg x 1/32 in. wd x 7/32 in. thk; molded bakelite case; 2 axial wire leads; Espey part no. 25.604 per spec JAN-C-5	Coupling V-108A and T-2
C-112		Same as C-108	Cathode bypass V-108A
C-113		Same as C-103	Cathode bypass V-108B
C-114		Not used	
C-115	3K3551232 16-C-32720-7533 3330 376 152 600	CAPACITOR, fixed: mica dielectric; JAN type CM35C512J; 5100 mmf ± 5%; 500 vdcw; temp coef letter C; 53/64 in. lg x 53/64 in. wd x 1/32 in. thk; molded bakelite case; 2 axial wire leads; Espey part no. 25.601; per spec JAN-C-5	Coupling trigger input to V-108A
C-116	3D9100-269 16-C-28558-1489 3330 313 889 996	CAPACITOR: silver mica button type; one section; 100 mmf ± 10%; 500 volts; hermetically sealed metal case, silver plated; .447 in. diam x 1/16 in. thk; wax impregnated; one solder lug term and one burron type term; no internal ground connections; terminal mounted; Erie Resistor Corp. type 370-CA; Espey Mfg. Co. part/dwg no. A25.653A	Micro wave bypass in RF output waveguide assembly
E-101	17-B-78253-3634	BOARD, terminal: general purpose; 36 Cambridge Thermionic Co. #1724C turret lugs; term. holes spaced 48/64 in. C to C; Formica type YN-25 laminated board; 9 1/16 in; lg x 1 7/8 in. wd x 5/32 in. thk; mtg holes 1/8 in. diam; Espey Mfg. Co. part/dwg no. B32.1299	Mounting board for resistors and capacitors located on bottom rear of framework
E-102	17-B-78138-2724	BOARD, terminal: chassis resistor; twenty Cambridge Thermionic Co. no. 1724C turret lugs; term. spaced 1 5/32 in. x 1/32 in. C to C; Formica type YN-25 laminated board; 4 3/8 in. lg x 1 5/8 in. wd x 5/32 in. thk; mounts by four 1/8 in. diam mtg holes spaced 4 1/32 in. x 7/8 in. C to C; Espey Mfg. Co. part/dwg no. B32.1298	Resistor board located on bottom rear of framework

TABLE 8-2. COMBINED PARTS AND SPARE PARTS LIST—Continued

REFERENCE DESIGNATION	STOCK NO., SIG. CORP. STANDARD NAVY AND AIR FORCE	NAME AND DESCRIPTION	LOCATING FUNCTION
E-103	17-B-77534-7858	BOARD, terminal: general purpose; two Cambridge Thermionic Co. #X1578C split term. lugs; term. holes spaced 2 3/8 in. C to C; Formica type YN-25 laminated board; 1 1/2 in. lg x 1/2 in. wd x 3/32 in. thk; mtg holes 7/64 in. diam; Espey Mfg. Co. part/dwg no. A32.1253	Terminal board for AC power
E-104	17-B-78099-5319	BOARD, terminal: amplifier resistor; seventeen Cambridge Thermionic Co. #1578C split term. lugs; irregularly spaced term. holes; Formica type YN-25 laminated board; 4 5/8 in. lg x 2 in. wd x 3/64 in. thk; five mtg holes 1/16 in. diam irregularly spaced; Espey Mfg. Co. part/dwg no. B32.1255	Mounting board for resistors and capacitors located in pulse amplifier unit
E-105		BOARD, terminal: amplifier general purpose; nine Cambridge Thermionic Co. #X1578C split term. lugs; irregularly spaced term. lugs; Formica type YN-25 laminated board; 4 5/8 in. lg x 2 in. wd x 1/64 in. thk; seven mtg holes 3/64 in. diam irregularly spaced; Espey Mfg. Co. part/dwg no. B32.1254	Terminal board for resistors and capacitors located in pulse amplifier unit
E-106	17-B-77686-4059	BOARD, terminal: amplifier; 5 Cambridge Thermionic Co. #X1578C split term. lugs; term. holes spaced 1 3/4 in. C to C; Formica type YN-25 laminated board; 2 1/8 in. lg x 1 3/8 in. wd x 3/32 in. thk; mtg holes 1/8 in. diam; Espey Mfg. Co. part/dwg no. A32.1252	Terminal board for connecting wires, located in pulse amplifier unit
E-107	17-B-77413-5771	BOARD: insulating; Formica YN-25; 3 1/8 in. lg x 1 1/2 in. wd x 3/32 in. thk; 3 mtg holes 1/8 in. diam irregularly spaced; Espey Mfg. Co. part/dwg no. A21.2089	Mounting board for signal width control
E-108		BLOCK, terminal: general purpose; 4 polyiron and nickel plated brass term., 4 soldered lugs; term. spaced 5/8 in. x 1 in. C to C; plastic natural type rectangular 5/8 in. lg (plus lg of term.) x .810 in. wd x .498 in. h; 4 mtg holes 1/8 in. diam; Espey Mfg. Co. part/dwg no. A32.1235	Terminal board located on thermistor bridge housing
E-109	8800 619 700	HOLDER, fuse: extractor type; single AGC cartridge fuse; black bakelite; 15 AMP current rating; 1/4 in. diam x 1 1/4 in. lg; 1/2 in. threaded body for panel mounting; one solder lug term. 13/32 in. diam x 1 3/8 in. lg; Bussman Mfg. Co. type HKP; Espey Mfg. Co. part no. 32.1192	Holds fuse F-101
E-110		Same as E-109	Holds fuse F-102
E-111		Same as E-109	Holds spare fuse F-103
E-112		Same as E-109	Holds spare fuse F-104
E-113	16-K-700349-996 3320 291 241 517	KNOB: round, fluted with heavy brass, chrome finished skirt; black bakelite; 1/4 in. shaft diam; two no. 8-32 thd set screws; no markings; 1 3/4 in. diam x 5/8 in. thk o/a; brass insert; shaft hole 7/64 in. d; includes dial lock; Espey Mfg. Co. part no. 7.205	
E-114	2Z5822-353 3320 292 241 525	KNOB: round; black bakelite fluted with skirt; for 1/4 in. diam shaft; single no. 8-32 x 3/32 in. cup point set screw; marked increase with arrow; 1 1/2 in. diam x 1 1/8 in. thk; brass sleeve insert; 1/8 in. lg shaft; Kurz-Kasch type S380-64-B-L-BB; Espey Mfg. Co. part no. 7.154	Knob for signal width
E-115		Same as E-113	Knob for phase
E-116	3320 292 241 588	KNOB: round; black bakelite; for 1/4 in. diam shaft; two no. 9-32 Allen head cup point set screws; 1 1/8 in. diam x 5/8 in. thk; brass sleeve insert; 9/16 in. lg shaft hole; Kurz-Kasch type S308-64-B-BB; Espey Mfg. Co. part no. 7.152	Knob for signal frequency

TABLE 8-2. COMBINED PARTS AND SPARE PARTS LIST—Continued

REFERENCE DESIGNATION	STOCK NO., SIG. CORP. STANDARD NAVY AND AIR FORCE	NAME AND DESCRIPTION	LOCATING FUNCTION
E-117	3320 083 350 610	KNOB: bar; black bakelite; for 1/4 in. diam shaft; two 6-32 cup point set screws; marked with projecting arrow; 1 1/4 in. lg x 3/4 in. wd x 5/8 in. high; aluminum insert; 9/16 in. lg shaft hole; The National Co. type no. HRP-P; Espey Mfg. Co. part no. 7.151	Knob for step attenuator
E-118	17-G-154211-801	GASKET: leakage protection; phosphor bronze; five holes; 1 5/8 in. lg x 1 5/8 in. wd; Espey Mfg. Co. part/dwg no. A27.3660	Waveguide flange gasket
E-119	7CEY FJ 387F	GASKET: leakage protection; polyiron; single hole; 2.525 OD x 2.230 I.D. x .156 thk; Espey Mfg. Co. part 27.4374	Klystron tube gasket
E-120	7CEY A21.2105A 16-H-65338-1710	HOLDER, crystal: for single silicon crystal; cylindrical body 7/8 in. diam x 1 5/8 in. lg; black bakelite; Espey Mfg. Co. part/dwg no. A21.2105A	Holds silicon crystal Y-101
E-121		DIAL ASSEMBLY: DBM attenuator; c/o dial Espey no. A3.220 and dial hub Espey no. A21.1908; steel black enamel finish with white markings; 3 in. diam x 9/32 in. thk; mts by one center bushing 5/8 in. OD x .25 in. ID; Espey Mfg. Co. part/dwg no. B3.223-A	DBM attenuator
E-122 thru E-130		Same as E-118	Spare waveguide flange gasket
E-131		Same as E-116	Knob for power set.
E-132		Same as E-116	Knob for DBM
E-133		Same as E-116	Knob for frequency meter
F-101	17-F-16302-100 8850 361 210	FUSE, cartridge: 2 amps; 250 volts; one time; glass body; ferrule terminals; 1/4 in. diam x 1 1/4 lg; Littlefuse Inc. type no. 312002; Espey Mfg. Co. part no. 32.196	Fuse, front panel mounted
F-102		Same as F-101	Fuse, front panel mounted
F-103		Same as F-101	Spare fuse, front panel mounted
F-104		Same as F-101	Spare fuse, front panel mounted
F-105		Same as F-101	Spare fuse, mounted in carrying case
H-101	16-N-88601-1051 7CEY A35.1538	NUT, plain, round: general purpose; brass, bright nickel pl; 5/8-24 NS-2 thd; 1 in. diam x 13/16 side diam x 1/8 in. thk; 2 sides flatted 13/16" across flats; Espey Mfg. Co. part/dwg no. A35.1538	Holds plumbing assembly to panel
H-102	41-W-2449	WRENCH: socket hexagonal; 3/32 in. across flats; 1 31/32 in. lg with short arm 3/4 in. lg, 5/32 in. across flats; black nickel plate, black Parkerized finish; head 90° offset from handle; short arm handle; special for no. 10 Allen head set screws; Allen wrench type no. 332; Espey Mfg. Co. part no. 27.2721	Tool
H-103	41-W-2446 7900 859 490	WRENCH: socket hexagonal; 5/64 in. across flats; 1 23/32 in. lg with short arm 31/64 in. lg, 5/64 in. across flats; black nickel plate black Parkerized finish; right angle elbow 23/32 in. lg short arm handle; special for no. 8 Allen head set screw; Allen wrench type no. 564; Espey Mfg. Co. part no. 35.888	Tool
H-104	16-R-503580-279 3300 287 178 460	RETAINER, ELECTRON TUBE: to hold vacuum tube; spring steel tempered; cadmium plate and iridite; held by one screw; 0.154 dia mtg hole; .079 in. thk, L shaped, long leg 1 11/16 in. lg with 15° bend toward short leg 31/32 in. from top, short leg 1/4 in. lg; holds 13/16 in. tube base; Espey Mfg. Co. part/dwg no. A21.2632	Holds tube V-103

TABLE 8-2. COMBINED PARTS AND SPARE PARTS LIST—Continued

REFERENCE DESIGNATION	STOCK NO., SIG. CORP. STANDARD NAVY AND AIR FORCE	NAME AND DESCRIPTION	LOCATING FUNCTION
H-105	3300 287 178 461	CLAMP, tube: general purpose; spring steel; cadmium plate and iridite; one screw employed; .020 in. thk L shaped long leg 1 7/32 in. short leg 3/8 in.; holds 13/16 in. tube base; Espey Mfg. Co. part/dwg no. A21.1928	Holds tube V-107
H-106		Same as H-105	Holds tube V-108
H-107	6600 324 379-3	GROMMET: rubber; 1/2 in. groove diam, groove width 1/16 in.; OD 5/8 in. thk; Espey Mfg. Co. part/dwg no. H40.15	Protects wires
I-101	8800 443 685	LAMP, pilot: 3 volt 150 ma; bulb T-1-1/4 clear; 1 1/32 in. lg x 3/8 7 in. diam special base; C-2R filament; burn any position; General Electric Co. part/dwg no. 323; Espey Mfg. Co. part no. 31.059	Pilot light
I-102		Same as I-101	Pilot light
I-103		Same as I-101	Spare pilot light
I-104		Same as I-101	Spare pilot light
I-105		Same as I-101	Spare pilot light
J-101	17-C-73446-3001 8850 215 400	RECEPTACLE, motor plug: 2 male parallel blades; straight type; power input reception; 2.031 in. lg x 1.187 deep x 1.375 in. diam; 15 amps 125 volts; cylindrical; black composition; mts by two mtg holes 1 3/8 in. diam two .136 screw mtg holes 1 3/4 in. centers spaced 1 13/16 in. C to C; Harvey Hubbel Co. part no. 6808; Espey Mfg. Co. part no. 32.1207	Power input receptacle
J-102	17-C-73108-5890 8850 667 760	JACK, female: one round female contact; straight type; trigger input reception; 1 in. lg x 1 in. wd x 1 in. thk; cylindrical diecast zinc shell; polystyrene insulation; 5/32 in. diam cable opening; mts by 1 in. sq mounting plate with four 5/32 in. mounting holes 3/4 in. diam spaced 23/32 in. x 23/32 in. C to C; American Phenolic Corp. part no. 83 1RTY; Espey Mfg. Co. part no. 32.435	Trigger input receptacle
L-101	3C575-35 16-R-29184-6745 3340 308 034 039	REACTOR: single section; 8 hy not to exceed 45ma; 340 ohms; 750 volts RMS test; open frame impregnated with fosterite; 2 13/16" lg x 1 13/16" wd x 1 3/4 in. h; four 0.169" diam mtg holes 2 7/16 in. x 1 7/16 in. centers; 2 solder lugs located on one end; Westinghouse Electric & Mfg. Co. type no. 7X7; Espey Mfg. Co. part/dwg no. B16.317	Filter choke in power supply
L-102	3C575-36 16-R-29098-6529 3340 308 034 040	REACTOR: sweep; single sect; 5.5 hy ± 20%—10% with no DC and 10V AC 1000 cycles applied; 227 ohms ± 10%; 750 volts RMS test; open frame impregnated with fosterite; 1 1/2" lg x 1 5/32" wd x 1 7/16" h; two 0.169" mounting holes 1 1/8 in. centers; 2 solder lug type term. located one on each end; Westinghouse Electric & Mfg. Co. no. 7X8; Espey Mfg. Co. part/dwg no. B16.318-B	Sweep reactor in modulating circuit of klystron tube
M-101	17-M-32372-9801 081-3-220	MICROAMMETER, DC: similar to JAN type MR26W; 150-0-150 micro-amp; round, steel, flush mtg case; hermetically sealed; barrel 2.21 max diam x 1 61/64 max dp behind flange, round flange 2.695 diam; 2% accuracy of full scale deflection; D'Arsenval movement; maximum full-scale terminal drop of 150 millivolts; 10 scale divisions from center to edge, black numerals on white background; self-contained; three 1/8 in. mtg holes spaced 120° apart on 1.22" radius; 2 stud term. 8-32 in. thd 3/4" max lg; Mil Instrument model no. 260, dwg no. D-182; Espey Mfg. Co. part no. 3.220; per spec JAN-I-6	Bridge current indicator

TABLE 8-2. COMBINED PARTS AND SPARE PARTS LIST—Continued

REFERENCE DESIGNATION	STOCK NO., SIG. CORP. STANDARD NAVY AND AIR FORCE	NAME AND DESCRIPTION	LOCATING FUNCTION
O-101	16-S-21226-1235 7CEY 21.2017	SHAFT ASSEMBLY: includes cable and two bushings; bronze; right lay flexible shaft; 5¾ in. lg x .238 in. diam 7½ in. lg o/a; mts by 2 bushings $\frac{3}{32}$ in. diam x $\frac{13}{64}$ in. thk; includes 2 coupling nuts ½-20 thread; S.S. White Dental Co. type 141; Espey Mfg. Co. part/dwg no. B21.2017	Opens and closes barn door
O-102	16-C-92551-2226 7CMA 39002	COUPLING, flexible: coupling for potentiometer and knob; c/o one square ceramic insulator ⅞ in. lg x ⅞ in. wd x $\frac{5}{16}$ in. thk, two phosphor-bronze NP springs with attached mtg bushes; peak flash over 3700V; 1¼ in. lg x 1¼ in. wd x ¾ in. thk; mts by 2 bushings with two Allen head set screws; James Millen Mfg. Co. type no. 39002; Espey Mfg. Co. part no. 21.1813	Coupling for R-137 potentiometer and knob
O-103	6510 16-C-69001-1020 3300 295 757 258	CHOKE, R.F.: broad band washer; polyiron; 0.372" OD; 0.125" ID diam .125 thk; Espey Mfg. Co. part/dwg no. A27.-3779A	Broad band washer
P-101	17-C-71416-2550 8850 467 455	CONNECTOR, female: one round female contact; JAN type UG-21B/U; straight type; 1⅞ in. lg x $\frac{13}{16}$ in. diam overall; 50 ohms characteristic impedance; cylindrical brass body, silver plated; teflon insert; $\frac{11}{16}$ in. diam cable opening; Espey part no. 32.003; per spec JAN-C-71	Power input plug p/o Z-102
P-102		Same as P-101	p/o Z-102
P-103	PL-259A 17-C-71414-2800 8850 460 433	CONNECTOR, plug: Navy type 49195; one round male contact; straight type; $\frac{11}{16}$ in. diam x $1\frac{9}{16}$ in. lg; cylindrical brass body silver plated; mica-filled bakelite insert; cable opening for .410 in. diam; cable mounted; multiple piece construction, tapered removable black shield which provides extra cable grip; Amphenol type 83-1SPN; Espey Mfg. Co. part no. 32.1113	
P-104		Same as P-103	p/o Cable Z-111
P-105	M-359A 17-C-67444-1275 8850 107 800	CONNECTOR, adapter: Navy type 49192A; male one end; female other; one round male contact and one round female contact; 90° angle type; adapts two straight connectors for 90° angle; $1\frac{3}{16}$ in. lg x $1\frac{7}{32}$ in. h x ⅝ in. diam; cylindrical zinc body, silver plated; polystyrene insert; Amphenol type 83-1AP; Espey Mfg. Co. part no. 32.1112	Adapter for P-103
P-106	8850 213 620	CONNECTOR, female contact: 2 flat parallel contacts; straight type; 1.375 in. diam x .968 in. high; 10 amp 259V, 15 amp 125V; cylindrical black composition; cable opening .406 in. to .625 in.; Hubbell type no. 7257 female body; Espey Mfg. Co. part no. 32.1206	p/o power cable Z-112
P-107	8850 216 900	CONNECTOR, male contact: 2 flat parallel blades; straight type; 1.531 in. diam x .531 in. high x .625 in. thk; 10 amp 250v, 15 amp 125v; cylindrical, special impact resisting composition, steel covered body; molded-in brass inserts; cable opening .296 in. to .562 in.; Hubbell type no. 7057 male cap; Espey Mfg. Co. part no. 32.355	p/o power cable Z-112
R-101	3RC20BF225K 16-R-51065-811 3300 381 168 240	RESISTOR, fixed: composition; JAN type RC20BF225K; 2.2 meg ohms ± 10%; ½ w; F characteristic; .468 in. lg x .249 in. diam; insulated, salt water immersion resistant; 2 axial wire lead term; Espey part no. R522-34; per spec JAN-R-11;	Plate load V-101
R-102	3RC42BF104K 16-R-50634-501 3300 381 516 220	RESISTOR, fixed: composition; JAN type RC42BF104K; 100000 ohms ± 10%; 2 w; F characteristic; .750 in. lg x .370 in. diam; insulated, salt water immersion resistant; 2 axial wire lead term; Espey part no. R-410-40; per spec JAN-R-11	Voltage divider plate V-102

TABLE 8-2. COMBINED PARTS AND SPARE PARTS LIST—Continued

REFERENCE DESIGNATION	STOCK NO., SIG. CORP. STANDARD NAVY AND AIR FORCE	NAME AND DESCRIPTION	LOCATING FUNCTION
R-103	3RC20BF333K 16-R-50417-811 3300 381 168 960	RESISTOR, fixed: composition; JAN type RC20BF333K; 33000 ohms ± 10%; ½ w; F; .468 in. lg x .249 in. diam; insulated, salt water immersion resistant; 2 axial wire lead term; Espey part no. R333-35; per spec JAN-R-11	Voltage divider plate V-102
R-104	3RC20BF154K 16-R-50678-811 3300 381 167 200	RESISTOR, fixed: composition; JAN type RC20BF154K; 150000 ohms ± 10%; ½ w; F characteristic; .468 in. lg x .249 in. diam; insulated, salt water immersion resistant; 2 axial wire lead term; Espey part no. R415-35; per spec JAN-R-11	Voltage divider screen grid V-103
R-105		Same as R-104	Voltage divider screen grid V-103
R-106	3RC42BF103K 16-R-50283-529 3300 381 600 106	RESISTOR, fixed: composition; JAN type RC42BF103K; 10000 ohms ± 10%; 2 w; F Characteristic; .750 in. lg x .370 in. diam; insulated, salt water immersion resistant; 2 axial wire lead term; Espey part no. R310-40; per spec JAN-R-11	Bleeder resistor V-106
R-107	3RC30BF304J 16-R-50749-751 3300 381 318 720	RESISTOR, fixed: composition; JAN type RC30BF304J; 300000 ohms ± 5%; 1 w; F characteristic; .750 in. lg x .280 in. diam; insulated, salt water immersion resistant; 2 axial wire lead term; Espey part no. R430-37; per spec JAN-R-11	Voltage divider control grid V-103
R-108	3RC30BF204J 16-R-50704-751	RESISTOR, fixed: composition; JAN type RC30BF204J; 200000 ohms ± 5%; 1 w; F characteristic; .750 in. lg x .280 in. diam; insulated salt water immersion resistant; 2 axial wire lead term; Espey part no. R-420-37; per spec JAN-R-11	Voltage divider control grid V-103
R-109	3RC20BF393K 16-R-50444-811 3300 381 169 380	RESISTOR, fixed: composition; JAN type RC20BF393K; 39000 ohms ± 10%; ½ w; F characteristic; .468 in. lg x .249 in. diam; insulated, salt water immersion resistant; 2 axial wire lead term; Espey part no. R-339-35; per spec JAN-R-11	Limiting resistor V-103
R-110		Not used.	
R-111		Not used.	
R-112	3300 067 110 412	RESISTOR, variable: composition; JAN type RV3ATFD104B; 100000 ohm ± 20%; ½ w 100°C max continuous operation; 3 solder lug term; enclosed metal case 1¼ in. diam $\frac{9}{16}$ in. depth; half round SS shaft ¼ in. diam x ⅞ in. lg; linear taper; insulated from case; normal torque; mts by bushing ⅜ in. —32 x ⅜ in. lg; Chicago Telephone Supply Co. type 35; Espey Mfg. Co. part/dwg no. 9.238; per spec JAN-R-94	V-104 reflector voltage control
R-113	3RC20BF334K 16-R-50759-811 3300 381 169 020	RESISTOR, fixed: composition; JAN type RC20BF334K; 330000 ohms ± 10%; ½ w; F characteristic; .468 in. lg x .249 in. diam; insulated, salt water immersion resistant; 2 axial wire lead term; Espey part no. R433-35; per spec JAN-R-11	Limiting resistor plate V-104
R-114		Same as R-113	Limiting resistor plate V-104
R-115	3RC21BF251J	RESISTOR, fixed: composition; JAN type RC21BF251J; 250 ohms ± 5%; ½ w; F characteristic; .655 in. lg x .249 in. diam; insulated, salt water immersion resistant; 2 axial wire lead term; Espey part no. R125-34; per spec JAN-R-11	Bridge circuit with R-116 and R-117
R-116		Same as R-115	Bridge circuit with R-115 and R-117
R-117		Same as R-115	Bridge circuit with R-115 and R-116

TABLE 8-2. COMBINED PARTS AND SPARE PARTS LIST—Continued

REFERENCE DESIGNATION	STOCK NO., SIG. CORP. STANDARD NAVY AND AIR FORCE	NAME AND DESCRIPTION	LOCATING FUNCTION
R-118	3RC20BF220J 16-R-49309-431 3300 381 167 780	RESISTOR, fixed: composition; JAN type RC20BF200J; 20 ohms ± 5%; ½ w; F characteristic; .468 in. lg x .249 in. diam; insulated, salt water immersion resistant; 2 axial wire lead term; Espey part no. R020-34; per spec JAN-R-11	Bridge compensating resistor
R-119		Same as R-115	Bridge arm resistor
R-120	3RC20BF390J 16-R-49390-431 3300 381 169 240	RESISTOR, fixed: composition; JAN type RC20BF390J; 39 ohms ± 5%; ½ w; F characteristic; .468 in. lg x .249 in. diam; insulated, salt water immersion resistant; 2 axial wire lead term; Espey part no. R039-34; per spec JAN-R-11	Drift compensating network resistor
R-121	3RC20BF471J 16-R-49768-431 3300 381 169 660	RESISTOR, fixed: composition; JAN type RC20BF471J; 470 ohms ± 5%; ½ w; F characteristic; .468 in. lg x .249 in. diam; insulated, salt water immersion resistant; 2 axial wire lead term; Espey part no. R147-34; per spec JAN-R-11	Drift compensating network resistor
R-122	3RC20BF360J 16-R-49381-431 3300 381 169 120	RESISTOR, fixed: composition; JAN type RC20BF360J; 36 ohms ± 5%; ½ w; F characteristic; .468 in. lg x .249 in. diam; insulated, salt water immersion resistant; 2 axial wire lead term; Espey part no. R036-34; per spec JAN-R-11	Drift compensating network resistor
R-123	3300 380 078 130	RESISTOR, variable: wire-wound; JAN type RA30A1FD-152AK; 1500 ohms ± 10%; 4 w; 3 solder lug term; enclosed metal case 1.78 in. diam x 1.25 in. d; slotted metal shaft ⅞ in. lg; linear taper; insulated contact arm; normal torque; mts by bushing ⅜-32 thd x ⅜ in. lg; Espey part no. 9.240; per spec JAN-R-19	Meter balance fine control
R-124	16-R-090933-8100 3300 067 335 200	RESISTOR, variable: wire wound; JAN type RA30A1SA-352AK; 3500 ohms ± 10%; 4 w; 3 solder lug term; enclosed metal case 1.78 in. diam x 1.25 in. d; slotted metal shaft ½ in. lg; linear taper; insulated contact arm; normal torque; mts by bushing ⅜-32 thd x ⅜ in. lg; Espey part no. 9.241; per spec JAN-R-19	Coarse meter balance control
R-125	3RC42BF103K 16-R-50283-529 3300 381 604 549	RESISTOR, fixed: composition; JAN type RC42BF103K; 6800 ohms ± 10%; ½ w; F characteristic; .750 in. lg x .370 in. diam; insulated, salt water immersion resistant; 2 axial wire lead term; Espey part no. R268-40; per spec JAN-R-11	Series dropping resistor for thermistor bridge circuit
R-126	3RC20BF472K 16-R-50129-811 3300 381 169 740	RESISTOR, fixed: composition; JAN type RC20BF390J; 4700 ohms ± 10%; ½ w; F characteristic; .468 in. lg x .249 in. diam; insulated, salt water immersion resistant; 2 axial wire lead term; Espey part no. R247-35; per spec JAN-R-11	Matching resistor V-107A
R-127		Same as R-103	Load resistor V-107
R-128	3RC20BF102K 16-R-49922-811 3300 381 166 100	RESISTOR, fixed: composition; JAN type no. RC20BF102K; ½ w; F characteristic; .468 in. lg x .249 in. diam; insulated, salt water immersion resistant; 2 axial wire lead term; Espey part no. R210-35; per spec JAN-R-11	Cathode bias resistor V-107A
R-129	3RC20BF104K 16-R-50633-81 3300 381 166 220	RESISTOR, fixed: composition; JAN type RC20BF104K; 100000 ohms ± 10%; ½ w; F characteristic; .468 in. lg x .249 in. diam; insulated, salt water immersion resistant; 2 axial wire lead term; Espey part no. R410-35; per spec JAN-R-11	Grid leak resistor V-107B
R-130	3RC30BF333K 16-R-50418-231 3300 381 318 960	RESISTOR, fixed: composition; JAN type RC30BF333K; 33000 ohms ± 10%; 1 w; F characteristic; .750 in. lg x .280 in. diam; insulated, salt water immersion resistant; 2 axial wire lead term; Espey part no. R333-38; per spec JAN-R-11	Load resistor V-107B
R-131		Same as R-129	Grid leak resistor V-108
R-132		Same as R-103	Load resistor V-108A

TABLE 8-2. COMBINED PARTS AND SPARE PARTS LIST—Continued

REFERENCE DESIGNATION	STOCK NO., SIG. CORP. STANDARD NAVY AND AIR FORCE	NAME AND DESCRIPTION	LOCATING FUNCTION
R-133		Same as R-128	Cathode resistor V-108B
R-134		Same as R-102	Voltage divider cathode V-108B
R-135	3RC20BF682K 16-R-50201-811 3300 381 600 118	RESISTOR, fixed: composition; JAN type RC20BF682K; 6800 ohms ± 10%; ½ w; F characteristic; .468 in. lg x .249 in. diam; insulated, salt water immersion resistant; 2 axial wire lead term; Espey part no. R268-35; per spec JAN-R-11	Cathode resistor V-108B
R-136		Not used.	
R-137	3300 381 167 940	RESISTOR, variable: wire wound; JAN type RA40A1FD-503AK; 50,000 ohms ±10%; 7 w; 3 solder lug term; enclosed metal case 2.31 in. diam x .94 in. d; slotted metal shaft ⅞ in. lg; linear taper; grounded contact arm; normal torque; mts by bushing ⅜-32 thd x ⅜ in. lg; Espey part no. 9.242; per spec JAN-R-19	Signal width control
R-138	16-R-49319-811 3300 067 350 300	RESISTOR, fixed: composition; JAN type RC20BF220K; 22 ohms ± 10%; ½ w; F characteristic; .468 in. lg x .249 in. diam; insulated, salt water immersion resistant; 2 axial wire lead term; Espey part no. R022-35; per spec JAN-R-11	Voltage dropping resistor pilot light I-101 and I-102
R-139	3300 066 118 100	RESISTOR, fixed: wire wound; 180 ohm ± 10%; 18 watts; untapped, fixed; 1⅜ in. diam x ⅜ in. thk; rigid form; ceramic base; 2 solder lug term.; one .196 in. diam mtg hole center of base; Ward-Leonard type no. 18D180; Espey Mfg. Co. part no. 14.349	Heater resistor for standby heating of test set
R-140		Same as R-139	Heater resistor for standby heating of test set
R-141		Same as R-138	Series resistor dropping Pilot Light I-101 and I-102
R-142	3300 067 110 509	RESISTOR, variable: composition; 1 meg ohm ± 20%; ½ watt; solder lug term.; enclosed metal case 1⅛ in. diam x .491 in. depth; SD shaft; linear taper; insulated from case; normal torque; mts by bushing ⅜ in. lg x ¼ in. diam; Chicago Telephone Supply Co. type 25; Espey Mfg. Co. part/dwg. no. 9.239	Sweep adjustment potentiometer
R-143		Same as R-125	Series dropping resistor thermistor for bridge circuit
R-144		Same as R-106	Bleeder resistor for V-106
R-145	3300 066 300 080	THERMISTOR: temperature compensating elements; metal envelope; .803 ohm at 75°F (24°C); 1¼ in. lg x ⅞ in. wd x ⅛ in high; no. 22 tinned copper lead 4 in. lg extending from envelope; four mtg holes .1285 in. diam 1 in. x ⅝ in. C to C; Espey Mfg. Co. part/dwg no. 14.357	Heater resistor for standby heating of test set.
R-146	3300 394 196 070	THERMISTOR: temperature compensating elements; metal envelope; 765 ohms at 75°F (24°C); 1¼ in. lg x ⅞ in. wd x ⅛ in. high; no. 22 tinned copper lead 4 in. lg extending from envelope; four mtg holes .1285 diam 1 in. x ⅝ in. C to C; Espey Mfg. Co. part/dwg no. 14.358	Temperature compensating element
R-147		Same as R-139	

TABLE 8-2. COMBINED PARTS AND SPARE PARTS LIST—Continued

REFERENCE DESIGNATION	STOCK NO., SIG. CORP. STANDARD NAVY AND AIR FORCE	NAME AND DESCRIPTION	LOCATING FUNCTION
R-148		RESISTOR, fixed: composition; JAN type RC10BF100K; 10 ohms ± 10%; ¼ w; F characteristic; .406 in. lg x .170 in. diam; insulated, salt water immersion resistant; 2 axial wire lead term; Espey part no. R010-32; per spec JAN-R-11; order no. NObsr-49265	
S-101	17-S-74139-4844 3300 395 739 045	SWITCH, toggle: D. P. D. T.; JAN type ST22N; 6 amp, 125v; metal body; 2⅛ in. lg x $\frac{33}{32}$ in. wd x $1\frac{9}{32}$ in. H o/a; bat type handle $\frac{11}{16}$ in. lg; locking action; 6 solder lug term; mts by bushing $\frac{13}{32}$ in. —32 thd x $\frac{13}{32}$ in. lg; Espey part no. 12.129; per spec JAN-S-23	Power switch front panel mounted
T-101	17-T-74295-2198 3340 296 937 732	TRANSFORMER; power: filament and plate; 115 volts 50-1600 C/S input; 4 output windings; output coil three-four 6.3 volts at 1.25 amps, coil five-six 5 volts at 2 amps, coil seven-eight-nine center tapped 1750 volts RMS at 29 MA, coil ten-eleven 6.3 volts at 1.7 amps; air coolant; open metal case; 3¾ in. lg x 2½ in. wd x 3½ in. high; 12 solder lug term, located 6 on either side; four $\frac{5}{32}$ in. diam mtg holes $2\frac{5}{16}$ in. x $2\frac{9}{16}$ C to C; Espey Mfg. Co. part/dwg no. H18.114	Power transformer
T-102	17-T-79551-5481 3340 296 949 068	TRANSFORMER: pulse transformer; three sectional winding, inner section 90 turns no. 33 wire, middle section 90 turns no. 33 wire, outer section 135 turns no. 38 wire; impregnated with fosterite; resistance windings 1-2 2.60 ohms ± 10%, 3-4 2.80 ohms ± 10% at 75 C, 5-6 14.5 ohms ± 10%; 1½ in. lg x $1\frac{7}{16}$ in. wd x 1½ in. high; 2 mtg holes .36 in. diam spaced 1⅛ in. C to C; Espey Mfg. Co. part/dwg no. B15.104	Pulse transformer
V-101	2J5R4GY 16-T-55444- 3300 234 550 000	TUBE, electron: JAN type 5R4-GY; full wave vacuum rectifier;	Power rectifier
V-102	2J6Y6G 16-T-56916 3300 234 820 000	TUBE, electron: JAN type 6Y6G; beam power amplifier	Voltage regulator
V-103	2J6SH7 16-T-56660 3300 234 710 000	TUBE, electron: JAN type 6SH7; pentode	Regulation amplifier
V-104	2J2K25 16-T-52625 3300 234 198 985	TUBE, electron: JAN type 2K25; cathode ray	Oscillator
V-105	2J0C3/VR105 16-T-53050 3300 234 006 400	TUBE, electron: JAN type OC3/FR105; voltage regulator	Voltage regulator
V-106		Same as V-105	Voltage regulator
V-107	2J6SL7GT 16-T-56677 3300 234 750 000	TUBE, electron: JAN type 6SL7-GT; twin triode	Amplifier and saw-tooth
V-108		Same as V-107	Amplifier and saw-tooth
W-101	IF425-9A 15-C-12200-525 3300 132 147 700	CABLE, R.F.: JAN type RG-9A/U; coaxial; 51 ohms impedance, 30 mmf/ft; 4000v RMS; 7 strands no. 21 AWG silver coated copper wire; .355 in. OD double braid outer conductor; polyethylene dielectric; Type II non-contaminating synthetic resin jacket; Espey part no. per spec JAN-C-17A	RF cable
W-102	IF425-11 15-C-12201-625 8860 337 600 211	CABLE, R.F.: JAN type RG-11/U; coaxial; 75 ohms impedance, 20.5 mmf/ft; 4000v RMS; 7 strands no. 26 AWG tinned copper wire; .350 in. OD single braid outer conductor; polyethylene dielectric; type I synthetic resin jacket; Espey part no. ; per spec JAN-C-17A	Video cable

TABLE 8-2. COMBINED PARTS AND SPARE PARTS LIST—Continued

REFERENCE DESIGNATION	STOCK NO., SIG. CORP. STANDARD NAVY AND AIR FORCE	NAME AND DESCRIPTION	LOCATING FUNCTION
W-103	3300 322 001 039	CABLE, power: portable installation; two no. 18 AWG stranded conductors; rubber insulated; rubber and cotton jacket; 750 volts working; round 31/64 in. diam; Espey Mfg. Co. part/dwg no. A13.152	Power cable
X-101	8850 891 980	SOCKET, tube: octal; contacts no. 3, 5 and 7 missing; one piece saddle mtg; two mtg holes 3/8 in. diam spaced 1 9/16 in. C to C; 1 3/4 in. diam x 33/32 in. h overall; phosphor bronze silver plated contacts; Amphenol type no. 77-MIP-8; Espey Mfg. Co. part/dwg no. 32.315	Holds V-101
X-102		Same as X-101	Holds V-102
X-103		Same as X-101	Holds V-103
X-104		Not used.	
X-105		Same as X-101	Holds V-105
X-106		Same as X-101	Holds V-106
X-107		Same as X-101	Holds V-107
X-108		Same as X-101	Holds V-108
Y-101	2JIN23B 16-T-51723-10 3300 234 137 350	CRYSTAL UNIT, rectifying: JAN type-1N23B; silicon crystal; design frequency 10,000 mc, conversion loss 6.5 db max; Sylvania Prod type no. 1N23B; Espey Mfg. Co. part/dwg no. 31.058; spec JAN-1A	Front panel Crystal rectifier
Y-102		Same as Y-101	Spare front panel crystal rectifier
Y-103		Same as Y-101	Spare front panel crystal rectifier
Z-101	AT-68/UP 7CAC 045705	ANTENNA, pick up: c/o 1 contact assembly Espey part/dwg no. A27.3844, 1 pickup horn Espey part/dwg no. B27.3836, 1 horn connector Espey part/dwg no. A32.1353, 1 connector sleeve Espey part/dwg no. A27.377; aluminum, black anodize finish; 8,500-9,600 mc freq range; 3.281 in. lg x 2 3/32 in. wide x 1 in. wd overall; mts by sleeve connector 1/16 in. lg w/no. 5/8-24EF-2 thd; Espey Mfg. Co. part/dwg no. B27.3846	Pick-up, center front of test set
Z-102	7CAC-170 265-42	LINE, RF transmission: Army-Navy type no. CG-92A/U(8); cable type JAN RG-9A/U; 8 ft. excluding terminations; 8 ft. 3 3/4 in. overall lg; c/o 2 connectors JAN type UG-21B/U; and 1 cable JAN type RG; tag on cable marked Espey Mfg. Co. part/dwg no. A27.4336; Espey Mfg. Co. part/dwg no. B13.160; cable per spec JAN-C-17A, connector per spec JAN-C-71A	RF cable assembly
Z-103	7CEY A21.2066	WAVEGUIDE, sub-assem: output sect; c/o waveguide with two projecting connectors; brass silver plated; 8500 meg to 9600 meg; 2 5/8 in. lg x 2 1/2 in. wd x 1 1/4 in. high; four mtg holes 1/16 in. diam spaced 1 1/16 x 1 1/4 in. C to C; Espey Mfg. Co. part/dwg no. A21.2066	RF output and detector sect, on front panel mounted
Z-104	16-W-21990-1499 7CEY B21.2040	WAVEGUIDE, section assem: waveguide; c/o gasket Espey part no. A27.3660, H-plane bend Espey part no. B21.2040, two E-plane bend Espey part no. B21.2039; zinc chromate with black lusterless enamel paint; 8500 meg to 9600 meg; 4 in. lg x 4 in. wd x 2 in. high; mts by four .179 in. diam holes on each end spaced .900 in. x 1.281 in. C to C; Espey Mfg. Co. part/dwg no. B21.2040 and B21.2039	Waveguide, center side of test set

TABLE 8-2. COMBINED PARTS AND SPARE PARTS LIST—Continued

REFERENCE DESIGNATION	STOCK NO., SIG. CORP. STANDARD NAVY AND AIR FORCE	NAME AND DESCRIPTION	LOCATING FUNCTION
Z-105	7CAC 075525	TEST SET, sub-assembly: power control attenuator for waveguide assem; c/o plate guide 4⅝ in. with 2 attaching flanges; 8500-9600 mc freq. range; brass case 6½ in. lg x 5⅝ in. wd x 3½ in. high; 2 mtg holes ⅜ in. diam spaced 1¾ in. C to C; calibrated dial plate; Espey Mfg. Co. part/dwg no. L9.252	Power control
Z-106	16-T-20551-1052 7CAC 979585	TEST SET ASSEMBLY, dial and wavemeter: for measuring frequency; c/o 1 plunger assem Espey part/dwg no. A21.2003, 1 dial assem Espey part/dwg no. A3.224, 1 indicator assem Espey part/dwg no. B3.228, 1 door assem Espey part/dwg no. B21.2007, 1 meter casing Espey part/dwg no. N21.2018, 1 cavity cover Espey part/dwg no. A22.626; 8500 meg to 9600 meg; 7⅞ in. lg x 6⅛ in. wd x 5⅞ in. high overall; four ⅜ in. diam mtg holes on 4¼ in. x 4¼ in. mtg centers; calibrated dial marked from 843 to 966; Espey Mfg. Co. part/dwg no. N3.230	Inner side of front panel measures frequency
Z-107	7CEY 21-1829	TEST SET, sub-assembly: signal source; c/o 2 springs, clip, term, block, tube cap, cover assem, shaft assem, tube nut subassem, stop mechanism assem; 6 $\frac{15}{16}$ in. lg x 4 in. wd x 5 in. high; mts by 4 mtg holes ⅜ in. diam spaced 1¼ in. C to C; marked "danger—high voltage"; Espey Mfg. Co. part/dwg no. 21.1829	Signal source, approximately center, front of test set
Z-108		Not used.	
Z-109	MX-435/UP 7CAC 851 000	THERMISTOR ASSEMBLY: measures RF power in waveguide; c/o bead thermistor, two disc thermistors and motor shunt resistor; 8500-9600 mc freq. range; 3 $\frac{19}{32}$ in. lg x 2 $\frac{31}{32}$ in. wd x 2 $\frac{17}{32}$ in. thk; 4 mtg holes ⅜ in. diam spaced 1⅜ in. C to C; Espey Mfg. Co. part/dwg no. L14.361-B	Measures power, center, side in test set
Z-110	16-A-97365-6101 7CAC 075 609	ATTENUATOR, step; parallel vane type; glass; 8500 meg to 9600 meg; brass silver plated; 40 db microwave; .1695 in. diam mtg holes on 1.280 in. x 1.280 in. centers; Espey Mfg. Co. part/dwg no. L.9251	Microwave attenuator
Z-111	15-C-12201-625 1600 322 981 795	LINE, RF, transmission: Army-Navy type no. CG-638/U; JAN type RG-11/U; six ft lg; 6 ft 1 $\frac{81}{64}$ in. lg o/a; one Navy type connector 49195 at each end; p/o Espey Test Set TS-147C/UP; Espey Mfg. Co. part/dwg no. B13.159	Video cable assembly to test set
Z-112	17-C-48226-1895 3300 322 001 039	CABLE ASSEMBLY, power: AN Cord CX-337/U (6); two no. 18 AWG stranded conductors; rubber insulated; 750 volts working; cotton and rubber jacket; round $\frac{7}{16}$ in. diam; 6 ft lg; one Hubbell Connector type 7257 one end and one Hubbell type Connector 7057 other end; Espey Mfg. Co. part/dwg no. B13.158	Connector to power source
Z-113		Same as Z-112	Spare connector to power source
Z-114		Same as Z-102	RF cable assembly
Z-115		Same as Z-111	Spare video cable assembly to test set
Z-116		Same as Z-109	Spare thermistor assembly, measures power, center side in test set

TABLE 8-3. CROSS REFERENCE PARTS LIST

JAN (OR AWS) DESIGNATION	KEY SYMBOL
AT-68/UP	Z-101
CM20D221J	C-111
CM35C103K	C-103
CM35C512J	C-115
CM35D472K	C-108
CP29A1EF103V	C-107
CP69B1EF503K	C-102
CP70E1DH405K	C-101
M-359A	P-105
MX-435/UP	Z-109
PL-259A	P-103
RA30A1FD152AK	R-123
RA30A1SA352AK	R-124
RA40A1FD503AK	R-137
RC20BF102K	R-128
RC20BF104K	R-129
RC20BF154K	R-104
RC20BF220J	R-118
RC20BF220K	R-138
RC20BF225K	R-101
RC20BF333K	R-103
RC20BF334K	R-113
RC20BF360J	R-122
RC20BF390J	R-120
RC20BF393K	R-109
RC20BF471J	R-121
RC20BF472K	R-126
RC20BF682K	R-135
RC21BF251J	R-115
RC30BF204J	R-108
RC30BF304J	R-107
RC30BF333K	R-130
RC42BF103K	R-106
RC42BF104K	R-102
RG-9A/U	W-101
RG-11/U	W-102
ST22N	S-101
UG-21B/U	P-101
2J0C3/VR-105	V-105
2JIN23B	Y-101
2J2K25	V-104
2J5R4GY	V-101
2J6SH7	V-103
2J6SL7GT	V-107
2J6Y6G	V-102

NAVY STOCK NO.	KEY SYMBOL
15-C-12200-525	W-101
15-C-12201-625	W-102
16-A-97365-6101	Z-110
16-C-28558-1489	C-116
16-C-29370-7606	C-111
16-C-32646-6818	C-108
16-C-32720-7533	C-115
16-C-33622-5227	C-103
16-C-42761-9100	C-107
16-C-49962-8969	C-101
16-C-69001-1020	O-103
16-C-92551-2226	O-102
16-H-65338-1710	E-120
16-K-700349-996	E-113
16-N-21990-1499	Z-104
16-N-88601-1051	H-101
16-R-090933-8100	R-124
16-R-29098-6529	L-102
16-R-29184-6745	L-101
16-R-49309-431	R-118
16-R-49319-811	R-138
16-R-49381-431	R-122
16-R-49390-431	R-120
16-R-49768-431	R-121
16-R-49922-811	R-128
16-R-50129-811	R-126
16-R-50201-811	R-135
16-R-50283-529	R-106
16-R-503580-279	H-104
16-R-50417-811	R-103
16-R-50418-231	R-130
16-R-50444-811	R-109
16-R-50633-811	R-129
16-R-50634-501	R-102
16-R-50678-811	R-104
16-R-50704-751	R-108
16-R-50749-751	R-107
16-R-50759-811	R-113
16-R-51065-811	R-101
16-S-21226-1235	O-101
16-T-20551-1052	Z-106
16-T-51723-10	Y-101
16-T-52625	V-104
16-T-53050	V-105
16-T-55444	V-101
16-T-56660	V-103
16-T-56677	V-107
16-T-56916	V-102
17-B-77413-5771	E-107
17-B-77534-7858	E-103
17-B-77686-4059	E-106
17-B-78099-5319	E-104
17-B-78138-2724	E-102
17-B-78253-3634	E-101
17-C-48226-1895	Z-112
17-C-67444-1275	P-105
17-C-71414-2800	P-103
17-C-71416-2550	P-101
17-C-73108-5890	J-102
17-C-73446-3001	J-101
17-F-16302-100	F-101
17-G-154211-801	E-118
17-M-32372-9801	M-101
17-S-74139-4844	S-101
17-T-74295-2198	
17-T-79551-5841	T-102

ASO STOCK NO.	KEY SYMBOL
081 3 220	M-101

TABLE 8-3. CROSS REFERENCE PARTS LIST—Continued

ASO STOCK NO.	KEY SYMBOL
1600 322 981 795	Z-111
3300 066 118 100	R-139
3300 066 300 080	R-145
3300 067 110 509	R-142
3300 067 110 412	R-112
3300 067 335 200	R-124
3300 067 350 300	R-138
3300 132 147 700	W-101
3300 234 006 400	V-105
3300 234 137 350	Y-101
3300 234 198 985	V-104
3300 234 550 000	V-101
3300 234 710 000	V-103
3300 234 750 000	V-107
3300 234 820 000	V-102
3300 287 178 460	H-104
3300 287 178 461	H-105
3300 295 757 258	O-103
3300 322 001 039	W-103
3300 380 078 130	R-123
3300 381 166 100	R-128
3300 381 166 220	R-129
3300 381 167 200	R-104
3300 381 167 780	R-118
3300 381 167 940	R-137
3300 381 168 240	R-101
3300 381 168 960	R-103
3300 381 169 020	R-113
3300 381 169 120	R-122
3300 381 169 240	R-120
3300 381 169 380	R-109
3300 381 169 660	R-121
3300 381 169 740	R-126
3300 381 318 720	R-107
3300 381 516 220	R-102
3300 381 600 106	R-106
3300 381 600 118	R-102
3300 381 604 549	
3300 394 196 070	R-145

ASO STOCK NO.	KEY SYMBOL
3300 395 739 045	S-101
3320 083 350 610	E-117
3320 291 241 517	E-113
3320 292 241 525	E-114
3320 292 241 588	E-116
3330 313 889 996	C-116
3330 316 263 390	C-102
3330 317 643 038	C-101
3330 317 680 913	C-107
3330 376 017 410	C-111
3330 376 144 100	C-103
3330 376 152 600	C-115
3330 576 151 835	C-108
3340 296 937 732	T-101
3340 296 949 068	T-102
3340 308 034 039	L-101
3340 308 034 040	L-102
6600 324 379 3	H-107
7900 859 490	H-103
8800 443 685	I-101
8800 619 700	E-109
8850 107 800	P-105
8850 213 620	P-106
8850 215 400	J-101
8850 216 900	P-107
8850 460 433	P-103
8850 467 455	P-101
8850 667 760	J-102
8850 891 980	X-101
8860 337 600 211	W-102

SIGNAL CORPS STOCK NO.	KEY SYMBOL
IF-425-9A	W-101
IF-425-11	W-102
2Z5822-353	E-113
3C575-35	L-101
3C595-36	L-102

SIGNAL CORPS STOCK NO.	KEY SYMBOL
3D9100-269	C-116
3DA10-484	C-107
3DA50-217	C-102
3DB4-296	C-101
3K2022142	C-111
3K3510311	C-103
3K3547241	C-108
3K3551232	C-115
3RC20BF102K	R-128
3RC20BF104K	R-129
3RC20BF154K	R-104
3RC20BF220J	R-118
3RC20BF220K	R-138
3RC20BF225K	R-101
3RC20BF333K	R-103
3RC20BF334K	R-113
3RC20BF360J	R-122
3RC20BF390J	R-120
3RC20BF393K	R-109
3RC20BF471J	R-121
3RC20BF472K	R-126
3RC20BF682K	R-135
3RC21BF251J	R-115
3RC30BF204J	R-108
3RC30BF304J	R-107
3RC30BF333K	R-130
3RC42BF103K	R-106
3RC42BF104K	R-102
41-W-2446	H-103
41-W-2449	H-102
6510	O-103
7CAC 045 705	Z-101
7CAC 075 525	Z-105
7CAC 075 609	Z-110
7CAC 170 265-42	Z-102
7CAC 851 000	Z-109
7CAC 979 585	Z-106
7CEY A21.2066	Z-103
7CEY A21.2105A	E-120

TABLE 8-3. CROSS REFERENCE PARTS LIST—Continued

SIGNAL CORPS STOCK NO.	KEY SYMBOL	SIGNAL CORPS STOCK NO.	KEY SYMBOL	SIGNAL CORPS STOCK NO.	KEY SYMBOL
7CEY A35.1538	H-101	7CEY FJ 387F	E-119	7CEY 21.1829	Z-107
7CEY B21.2040	Z-104	7CEY 21.2017	O-101	7CMA 39002	O-102

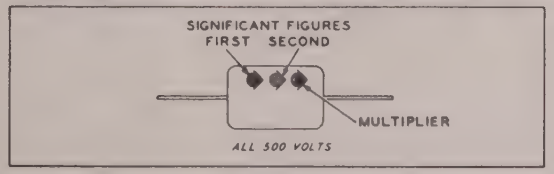
TABLE 8-4. LIST OF MANUFACTURERS

ABBREVIATIONS	PREFIX	NAME	ADDRESS
White SS	CA	S.S. White Dental Co.	10 E. 46th St., N. Y. C., N. Y.
Sangamo	CAN	Sangamo Electric Co.	1935 Funk St., Springfield, Ill.
Kings Electron	CANS	Kings Electronics Co.	372 Classon Ave., Brooklyn, N. Y.
WL	CAO	Ward Leonard Electric Co.	Mount Vernon, New York
Hewlett-Packard	CAQI	Hewlett-Packard Co.	395 Page Rd., Palo Alto, Calif.
AlSiMag	CAS	American Lava Corp.	Chattanooga, Tenn.
Aerovox	CAW	Aerovox Corp.	New Bedford, Mass.
Kurz-Kasch	CAUP	Kurtz-Kasch Inc.	1421 S. Broadway, Dayton, Ohio
Wemco	CAY	Westinghouse Electric Co.	2519 Williams Ave., Baltimore, Md.
Allen Mfg.	CAYT	Allen Mfg. Co.	100 Sheldon St., Hartford, Conn.
U. S. Rubber	CBAK	U. S. Rubber Co.	1230 6th Ave., New York, N. Y.
Corning Glass	CBI	Corning Glass Works	1943 Crystal St., Corning, N. Y.
Waltham Watch	CBIB	Waltham Horological Corp.	Waltham, Mass.
Fast	CBV	John E. Fast Co.	3123 N. Crawford Ave., Chicago, Ill.
AB	CBZ	Allen Bradley	118 W. Greenfield Ave., Milwaukee, Wis.
Crowley, H. L.	CCJ	Henry L. Crowley Co.	1 Central Ave., West Orange, N. J.
Dubilier	CD	Cornell Dubilier	1000 Hamilton Blvd., So. Plainfield, N. J.
Erie	CER	Erie Resistor	644 W. 12th St., Erie, Penn.
Buss	CFA	Bussman Mfg. Co.	2538 University Ave., St. Louis, Mo.
Fed Tel & Rad	CFT	Federal Telephone & Radio Corp.	100 Kingsland Road, Clifton, N. J.
Sylvania Prod.	CHS	Sylvania Products Inc.	Emporium, Penn.
Hubbell	CHV	Harvey Hubbell Inc.	447 Concord Ave., Bridgeport, Conn.
Millen	CJA	James Millen Co.	150 Exchange St., Malden, Mass.
Espey	CKE	Espey Mfg. Co.	528 East 72nd Street, N. Y., N. Y.
Littlefuse	CLF	Littlefuse Inc.	4765 Ravenswood Ave., Chicago, Ill.
Leeds & North	CLN	Leeds & Northrup	4901 Stenton Ave., Philadelphia, Penna.
Cinch	CMG	Cinch Mfg. Co.	2239 W. VanBuren St., Chicago, Ill.
Micro Sw	CMU	Micro Switch Corp.	Freeport, Ill.
Marion Elec. Ins.	CMY	Marion Electrical Instrument Company	Manchester, N. H.
Natl Co.	CNA	National Co.	61 Sherman St., Malden, Mass.
Amphenol	CPH	American Phenolic Corp.	1830 S 54th Ave.. Chicago, Ill.
RCA	CRC	R C A Mfg.	Harrisson, N. J.
Raytheon	CRP	Raytheon Mfg. Co.	190 Willow St., Waltham, Mass.
Sperry Gyro	CS	Sperry Gyroscope	Great Neck, L. I., N. Y.
CTS	CTC	Chicago Telephone Supply Co.	Elkhart, Ind.

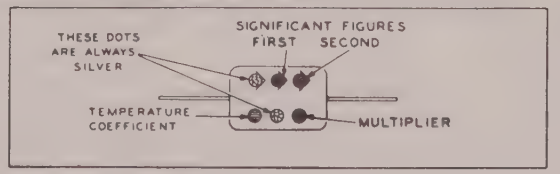
TABLE 8-7. APPLICABLE COLOR CODES

CAPACITOR COLOR CODES

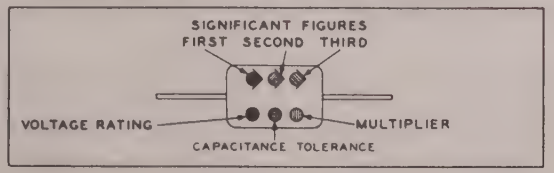
RMA 3-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



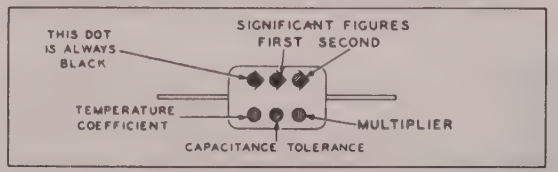
JAN 6-DOT COLOR CODE FOR PAPER-DIELECTRIC CAPACITORS



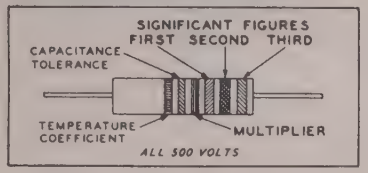
RMA 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS



JAN 6-DOT COLOR CODE FOR MICA-DIELECTRIC CAPACITORS

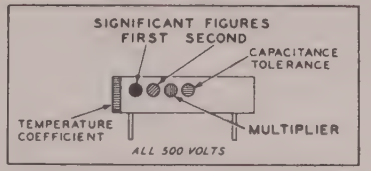


RMA COLOR CODE FOR TUBULAR CERAMIC-DIELECTRIC CAPACITORS

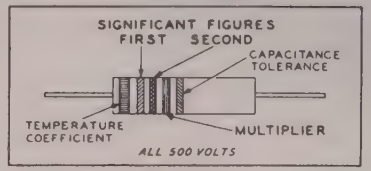


JAN COLOR CODE FOR FIXED CERAMIC-DIELECTRIC CAPACITORS

RADIAL TYPE NON-INSULATED



AXIAL TYPE INSULATED



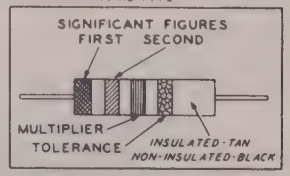
RMA: RADIO MANUFACTURERS ASSOCIATION
JAN: JOINT ARMY-NAVY

RESISTORS				CAPACITORS				
				MULTIPLIER				
TOLERANCE	MULTIPLIER	SIGNIFICANT FIGURE	COLOR	RMA MICA AND CERAMIC-DIELECTRIC	JAN MICA AND PAPER-DIELECTRIC	JAN CERAMIC DIELECTRIC	VOLTAGE RATING	TEMPERATURE COEFFICIENT
	1	0	BLACK	1	1	1		A
	10	1	BROWN	10	10	10	100	B
	100	2	RED	100	100	100	200	C
	1,000	3	ORANGE	1,000	1000	1000	300	D
	10,000	4	YELLOW	10,000			400	E
	100,000	5	GREEN	100,000			500	F
	1,000,000	6	BLUE	1,000,000			600	G
	10,000,000	7	VIOLET	10,000,000			700	
	100,000,000	8	GRAY	100,000,000		0.01	800	
	1,000,000,000	9	WHITE	1,000,000,000		0.1	900	
5	0.1		GOLD	0.1	0.1		1000	
10	0.01		SILVER	0.01	0.01		2000	
20			NO COLOR				500	

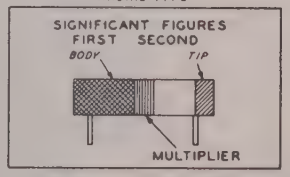
RESISTOR COLOR CODES

RMA COLOR CODE FOR FIXED COMPOSITION RESISTORS

AXIAL TYPE

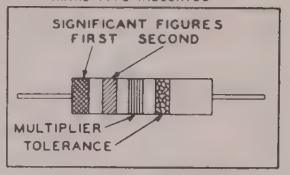


RADIAL TYPE

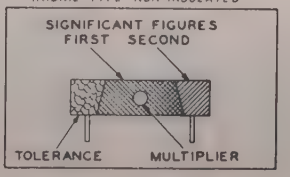


JAN COLOR CODE FOR FIXED COMPOSITION RESISTORS

AXIAL TYPE INSULATED



RADIAL TYPE NON-INSULATED



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